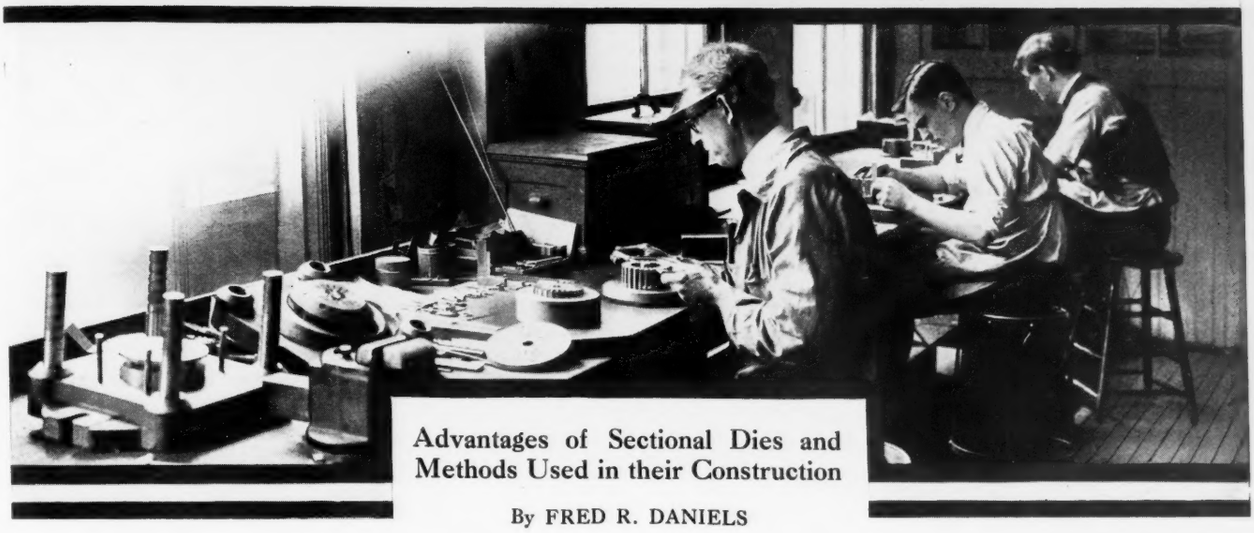
Sectional Blanking and Piercing Dies



Advantages of Sectional Dies and Methods Used in their Construction

By FRED R. DANIELS

CERTAIN advantages are claimed for the sectional stamping die over the solid die. In making repairs on dies of this type, it is only necessary to remove the damaged section and replace it with a new part. Other things being equal, this is a decided advantage. Furthermore, difficulties encountered in hardening a large solid die-block are not met with in the case of the sectional die: and each section can be accurately ground and fitted after hardening, thereby correcting errors due to distortion in hardening. In this way, each section can be made identical with every other. In the case of solid dies, errors due to distortion produced by the hardening process are exceedingly difficult to correct.

The accuracy that can be obtained in making sectional dies is also of importance. In order to finish the slots in the solid die accurately, a great deal of difficulty and considerable expense are involved. In fact, the inaccessibility of the surfaces to be finished in a solid die adds to the cost of manufacture sufficiently to balance, in large measure, the expense incident to finishing every member of a sectional die.

It is also said that with the sectional construction the dies can be made thicker than when made solid, which allows for many regrinds and greatly increases the life of the dies The sectional construction is incorporated in the combination blanking and perforating die illustrated in Fig. 1, as well as in the single-action follow-die shown in Fig. 2. Both of these were made by William P. Stein & Co., Rochester, N. Y., whose manufacturing methods are described in this article.

Sectional dies are used extensively in the production of armature laminations for electric motors and generators, and are also applicable to the manufacture of other classes of stampings containing a large number of perforations. The only essential difference in design between the sectional lamination die and the solid die is that the punch holes in the sectional die are formed by sections arranged radially and accurately fitted and assembled on a plate. These assembled sections form the lower die member; the punches, also assembled on a plate, are aligned with the lower die, as in sub-press construction. The present article describes methods used in manufacturing sectional blanking and piercing dies.

The illustration Fig. 1 shows the construction of a typical combination sectional die. The design of the stator stamping produced in this die is indicated in the plan view at the right, and the punch and die sections are shown separately at the left.

Sectional Die Construction

The die sections *A* and punches *B* (there are twenty-five of each), are fastened by machine screws to plates *C* and *D*. The die sections fit around a central die bushing *E*, and a spacer ring *F* is used to build up the die to the level of the fastening lugs on the sections, thereby furnishing a locating surface for the soft steel shrink ring *G* which is assembled around the die sections. By making this ring of unhardened steel, it may be faced off when the length of the die sections has been reduced by grinding to such a degree that there is no longer space for the blanking stripper plate *H* to operate. This plate strips the blanked stock, and is operated by a knock-out mechanism on the press through the medium of plate *I* and the rods extending from it through to the stripper *H*.

The blanking die *J* is fastened to the upper die member by bolts passing through the multiple punch-plate *D* and the plate that carries center-punch *K*. This die has a working clearance for punches *B*. The descent of the press ram causes the blanking die to depress stripper *H* as it blanks the stock, at the same time that the punches perforate the stock and enter the lower die openings. The scrap from the perforating operation is ejected by positive knock-outs which

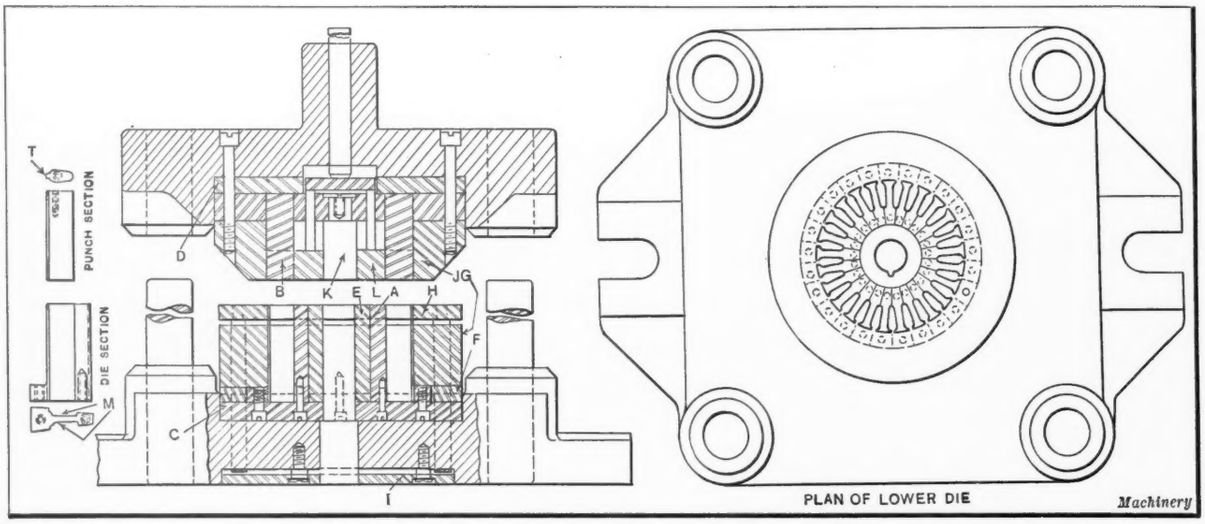


Fig. 1. Sectional and Plan Views of Compound Blanking and Perforating Dies of Built-up Construction

operate in the lower die openings, and the scrap from the center hole drops through the die.

Center-punch *K* is surrounded by a soft steel punch stripper *L*, which operates freely over the center-punch as well as over the punches *B*. Its purpose is to eject the stator stamping from the upper die member, and it is operated by the upper knock-out on the machine. The pins that back up this stripper extend through the center-punch plate and are of such length as to allow an air space between the punch-plate and the stripper. As the punches and the die *J* are reduced by grinding, it becomes necessary, of course, to shorten these pins in order to bring the face of stripper *L* into the same plane as the ends of the punches and die. The punch-block and the die-block are made of cast iron or soft steel, and are aligned by means of four sub-press posts.

It should not be necessary to describe in detail the construction of the follow-die shown in Fig. 2, except to state that the part that is of sectional construction is identical with the combination die, and that the blanking is performed separately in the die at the left. For locating the perforated stock in the second position, after the multiple punches have first operated, a post *A* enters the central hole while the second series of perforations is being made. Then the stock is advanced to the third position for blanking. During this and all subsequent operations, the stock is properly located by post *A* and the centering punch in blanking punch *B*. In this illustration the perforating punches *C* are shown conventionally; however their actual arrangement is very similar to that illustrated in Fig. 1.

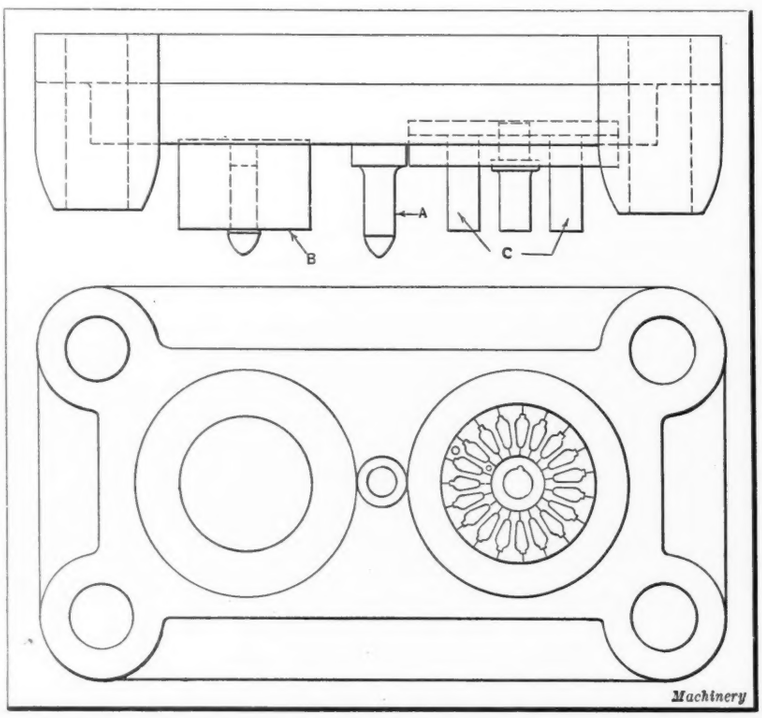


Fig. 2. Follow-die in which the Perforating Die is of Sectional Construction

In the manufacture of sectional dies the principal operation is grinding, and little else of mechanical interest is involved. In the plant of William P. Stein & Co., the punches and the die sections for lamination dies are made from a high-carbon water-hardening tool steel having a carbon content of from 1.30 to 1.40 per cent. This material is used on account of the extreme hardness and durable quality which it has when properly hardened and tempered.

The bars of steel are cut to the required length to form the die section and punch blanks, and are then milled to shape. Fig. 3 illustrates the form-milling operation by means of which the contour surfaces of the die sections (see Fig. 1) are produced. The operation is an ordinary one, and consists of locating the sections at the proper angle, which is done by employing a universal milling vise with dial adjustment. A No. 2 Cincinnati universal milling machine and a formed milling cutter are used for this operation. An allowance of 0.0075 inch on each surface is made for grinding. Before hardening, both the die and punch blanks are drilled and tapped at one end for machine screws by means of which they are fastened to the plate that holds them in the die and during certain grinding operations. These holes are located by bushing plates which fit on the end of the sections and are located by small pins positioned according to the sectional shape of the work.

Some manufacturers do not advocate the use of a water-hardening steel for dies, principally on account of the difficulty encountered in hardening, but in the case of a sectional die where distortion can be corrected by grinding all over, the experience of William P. Stein & Co. has shown that a water-hardening steel is superior to any other. The engineers of the company state that motor builders

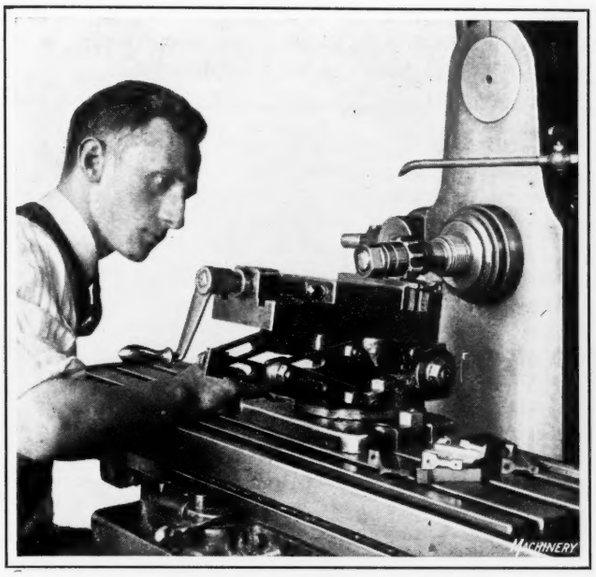


Fig. 3. Form-milling the Sides of the Die Sections

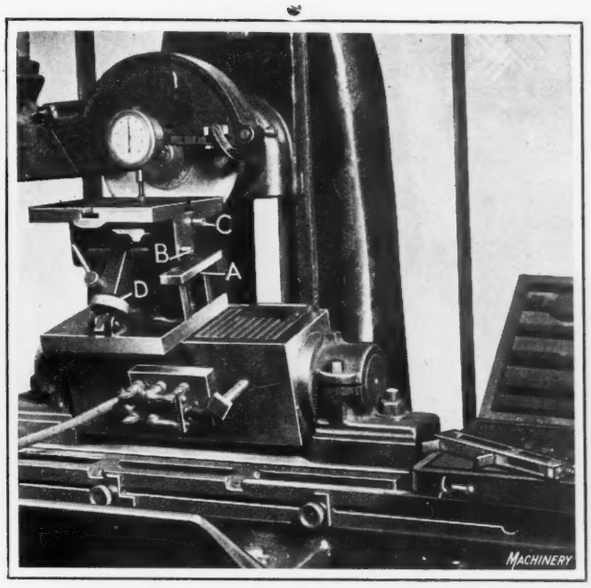


Fig. 4. Grinding Angular Sides of Die Sections

using these sectional dies report that from 50,000 to 100,000 motor stampings have been produced with one set of dies without regrinding. Furthermore, the length of the die sections permits grinding away about 1½ inches of metal, which, under normal conditions, removing about 1/64 inch per grind, would be equivalent to ninety-six regrinds. From this statement of the manufacturers it will be seen that the production from one set of sectional dies may easily run into the millions.

Handling of the parts in the fire, in quenching and tempering, must of course be done by experts. In general, the steel is heated to about 1450 degrees F. and quenched in brine, which gives extreme hardness, but which sets up a severe molecular strain in the material. To relieve this strain, the work is tempered in oil at a temperature of 425 degrees F. for approximately thirty minutes. Any distortion resulting from heat-treatment is immaterial, at this stage of manufacture, as this is afterward corrected by grinding. Each part must pass a scleroscope hardness test before delivery to the grinding department. Not only is it important that the proper degree of hardness be obtained, but also that each punch and die section in a die have the same hardness. It will be readily understood that if any one of the sections is not as hard as the others, a vulnerable spot is produced which wears quickly and consequently greatly shortens the life of the dies.

Close Grinding Limits Necessary

The grinding of the punches and die sections is essentially the same for both the compound and the single-action dies. In both cases, the hardened parts are ground all over so that each section and each die is a duplicate of each other within a limit of 0.0001 inch on every dimension. Between each punch and each die opening, a working allowance is made, equal to 5 per cent of the thickness of the stock from which the stampings are made. That is, for a stamping 0.020 inch thick, there would be a theoretical space all around, between the punches and die sections, of 0.001 inch. On the single-action push-through die, where no ejectors are provided for removing the scrap from the dies, it is necessary to have a slight taper in the die openings. Accordingly, each section going into a die of this kind is ground to produce a hole having a taper of about 0.004 inch per inch of length; that is, 0.002 inch per inch on both contour surfaces of every die section. In other respects, the grinding operations on both the combination and push-through dies are the same.

The die sections and punches are held on swivel magnetic chucks during grinding, which must be accurately set at the proper angle. This setting is important, as often twenty-five or more sections are used in a die and errors in the included angle of die sections accumulate rapidly, resulting

Fig. 5. Grinding the Flat Surfaces of the Die Sections

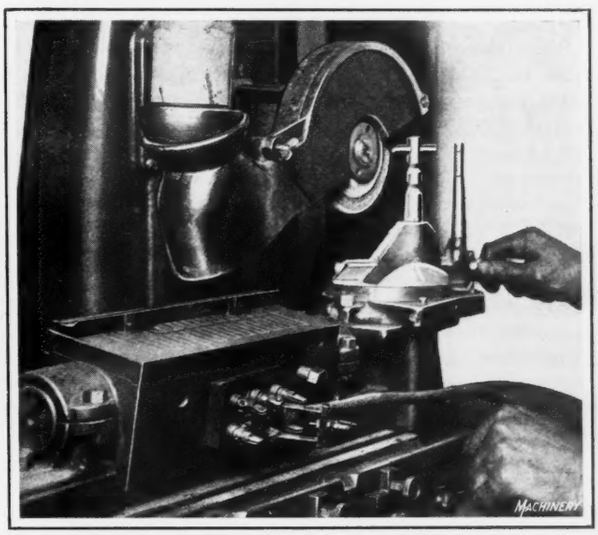


Fig. 6. Dressing the Wheel before grinding Radial Surfaces

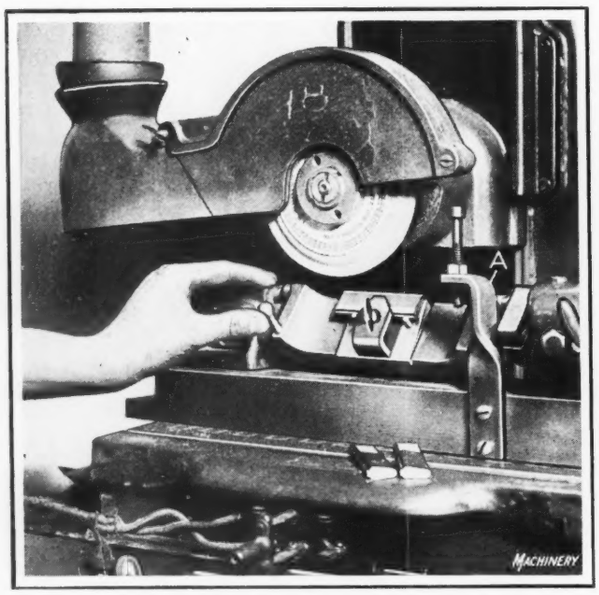


Fig. 7. Cradle Fixture in which the Radial Surfaces of the Punches are ground

in either an over-size or an under-size stamping and other inaccuracies which it is almost impossible to predetermine. Fig. 4 illustrates the method of setting the swivel magnetic chuck to the correct angle. An approximate setting can be obtained by means of the graduated scale on the chuck, but this does not give the necessary degree of accuracy.

Establishing Angularity of Working Surface for Grinding

The angular setting of the swivel chuck is obtained by the supplementary use of a sine angle-plate, a dial indicator, and precision gage-blocks. A Walker magnetic chuck is used, the working surface of which is set at the approximate angle by means of the graduated dial. If it is assumed that there are twenty-five die sections, then the included angle between the sides of each section will be 360 ÷ 25, or 14 degrees 24 minutes. The sine angle-plate, shown on the magnetic chuck in the illustration Fig. 4 is then set to this angle.

It will be seen that there are two hardened and ground measuring plugs on the angle-plate. These are located a unit distance from the center on which the T-slotted table swivels. Measurements can be taken from the under side of shelf *A* over either of these measuring plugs, according to whether the sine of the angle or the sine of its complement is being used in the calculations (the sine of the complement angle will, of course, be the same as the cosine of the angle.)

Since the distance from the center of rotation of the table to the outer periphery of each of the two plugs is unity, then a measurement taken from the shelf over plug *B* will give the sine of 14 degrees 24 minutes, if the distance from the center of rotation to the under side of shelf *A* is subtracted. If the latter distance is known to be 1 inch, then the measurement over the plug should be 1.24869 inches. Similarly, if the measurement is taken over plug *C*, the cosine of the angle will be obtained, and the correct measurement would be 1.96858 inches. To obtain either of these measurements, the holder furnished with precision gage-blocks can be readily set to caliper the required measurement. In adjusting the working surface of the sine angle-plate, a telescopic adjusting screw *D* is employed, and after the measurement has been obtained the position is secured by means of a lock-screw.

A dial indicator is then clamped in any convenient position, as for example, to the wheel guard, while the indicator point is permitted to ride on the table of the angle-plate as the machine table is manipulated. Errors in the original setting of the magnetic chuck are then noted and corrected. The dial indicator used in this work is graduated to ten-thousandths inch, so that very slight errors in the setting of the magnetic chuck can be detected.

Grinding the Die Sections

The setting of the magnetic chuck at the correct angle establishes a working surface from which the desired accuracy in the included angle of die sections and punches can be obtained, but expert workmanship is required to produce this result. The grinding of the sides of the die sections is illustrated in Fig. 5. For this operation a No. 2 B & S surface grinder, equipped with a Walker swiveling magnetic chuck and a No. 80-I Norton alundum wheel is used. A square-faced wheel is used for grinding the angular sides, the surfaces *M*, Fig. 1, and the surfaces forming the fit for the tongue *T* on the punch section.

In grinding the surfaces forming the rounded end of the die openings, the same set-up is used, but the grinding wheel is dressed to the proper radius to give the desired curvature. The preparation of the wheel for this operation is illustrated in Fig. 6, where a radius grinding-wheel dresser, employing a diamond tool, is being used. The length of radial adjustment of this tool permits dressing the wheel to any radius within the limitations of the tool. This grinding operation is performed on a No. 2 B & S surface grinding machine equipped with a swiveling magnetic chuck. Next the outer and inner circular surfaces of the sections are ground, after they have been properly attached to a retainer plate. These operations are performed on a No. 13 B & S cylindrical grinder using a No. 60-I Norton wheel.

The die sections have thus been ground all over, and, after inspection, are returned to the grinding machines where finish-grinding operations are performed on all contour surfaces to produce a working clearance for the punches. If the dies are of the single-action push-through type, the finish-grinding operation produces a taper hole, and in locating the work the set-up shown in Fig. 5 is used, but one end of the sections is raised with a shim of proper thickness. The section shown on the chuck is 1 inch long and a shim 0.002 inch thick is used when grinding the taper; thicker shims are used under die sections of greater length to give the same rate of taper. Die sections for combination dies form straight holes, and for such dies the finish-grinding produces a working clearance for the punches of 5 per cent of the stock thickness. The finish-ground sections, still magnetized, are wrung together after grinding, and a master punch is used as a plug to gage the hole formed by every pair of sections.

Fig. 8. Grinding the Punches to fit the Die Ring after assembling in the Punch-plate

Grinding the Punches

The sides of the punches are usually angular, as shown in Fig. 1, and they are ground on a swivel magnetic chuck. For grinding the radii at the ends, a swivel-block fixture is used in the manner indicated in Fig. 7. Two punches are shown lying on the table of the No. 2 B & S surface grinder that is used in this operation. The fixture is held on a magnetic chuck and carries a cradle mounted between centers, on which the punches may be located, resting against two pins and secured by a clamp. The operator rocks this cradle back and forth as the table reciprocates until the radius being ground becomes nicely blended with the angular sides of the punch.

The swing of the cradle is limited by two adjustable stops, one at the front shown at *A*, and a similar one at the rear. By simply adjusting these stops, all punches in a set may be ground alike, with a continuous even surface joining the sides. The radii on each side of the tongue at the opposite side of the punch are also ground in this fixture. The wheel has a square face, and by proper adjustment a sharp corner can be maintained at the root of the tongue adjoining each radius. For these operations a No. 80-I Norton alundum wheel is employed.

Another operation on the punches, which is indispensable for the efficient operation of the dies, is grinding the peripheries after they have been assembled in the punch-plate. This operation is performed on a No. 13 B & S cylindrical grinder, as illustrated in Fig. 8. A No. 60-I Norton alundum wheel is used, and the set-up is similar to that used in grinding the assembled die sections; in this case, however, the die sections are ground on both the outer and inner circular surfaces, the inner surfaces subsequently being fitted around the center die bushing *E*, Fig. 1. In grinding the punches to fit the die ring through which they operate, a clearance of 0.0075 inch is provided, that is, the diameter is ground 0.015 inch less than the diameter of the die ring.

Operations on the Punch Stripper

The soft steel punch stripper *L*, Fig. 1, works over the punches, and the holes in it must, of course, be accurately spaced and provided with proper working clearances. The slots are located by first drilling a series of holes, using a dividing head to space their location accurately. A broach of special shape is then used to finish these holes, the work being performed on an arbor press. After broaching, the holes are slotted open at the periphery of the stripper, as illustrated in Fig. 9. The swivel fixture on which the stripper is seated during the operation is rotated from hole to hole in locating the tool centrally in each broached slot. The operation is performed on a No. 2 Cincinnati universal milling machine equipped with a slotting head, and the work is fed backward past the vertically reciprocating cutter by hand. Accurate spacing is the main consideration in machining these slots and the assembled punches serve as a gage. However, there is considerable leeway in regard to the clearance for the punches.

Fig. 9. Slotting the Stripper to accommodate the Key Section on the Punches

Fig. 10. Fitting the Die Sections preparatory to shrinking on the Retainer Ring

Final Bench Work and Assembling

After all the die sections have been carefully ground, they are delivered to the bench where the final assembling and fitting is done. The center bushing, which is a hardened and ground steel member, is then fastened to the plate on which the circular surfaces were ground, and each die section is carefully stoned and fitted around this bushing by hand. This operation is illustrated in Fig. 10. After the sections have been fitted, the die openings are matched up with the assembled punches, and the die sections fastened to the plate. This operation is of the highest importance, as the efficiency of the die depends largely on the skill with which the die sections are finally assembled.

After the sections have been fastened to the plate, a soft steel shrink ring, shown lying on the bench, is shrunk over the die sections. This die ring is sufficiently narrow to allow space for the operation of the blanking stripper plate *H*, Fig. 1, and is made of machine steel so that it can be faced off as the dies are ground down in sharpening. The blanking die ring *J* is a carefully hardened and ground member assembled over the punches and fastened to the upper die-holder by bolts, as shown in the sectional view.

* * *

In connection with the presidential address of Dean Kimball of the College of Engineering of Cornell University before the American Society of Mechanical Engineers, on the future leadership of the engineer in the world of affairs, it is interesting to note that the Carnegie Institute of Technology has made an investigation as to the positions now occupied by graduates of the institute. This investigation indicates that approximately 67 per cent of the graduates between 1908 and 1921 are now engaged in commercial or managerial work, which is substantial proof of the need of commercial training in engineering college courses. The majority of engineering graduates use their technical education as a means of entering commercial or managerial work.

STANDARDIZATION OF NUTS AND BOLTS

By ANDREW J. SCHWARTZ

The urgent need for standardization of nuts and bolt heads was discussed in April, 1921, MACHINERY, on page 791. At that time an appeal was made for a single standard for the width across flats, or the "short diameter" of bolt heads and nuts, since, as pointed out in that article, there are now seven standards of widths in actual use. There is a wide divergence in these standards; for example, in the table published in the preceding article it will be seen that in the case of a ⅝-inch diameter bolt head or nut, there is a difference of ⅜ inch in the short diameters of the largest and smallest of these standards.

The writer has since given the subject further study and has reached the conclusion that the standard width of bolt and nut adopted by the Society of Automotive Engineers should be taken as an international, or at least a national standard. These proportions of nuts and bolt heads are used almost exclusively in automobile engines, and their reliability has been thoroughly tested under severe conditions in aircraft construction. Furthermore, the saving in

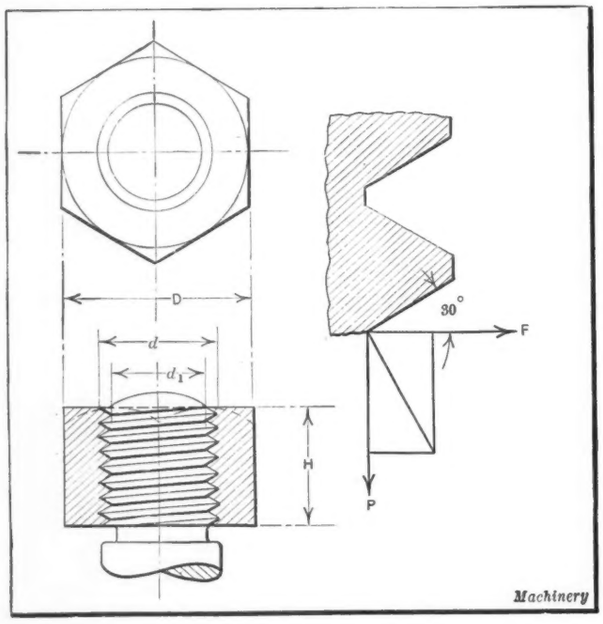


Diagram used in investigating Standards for Nuts and Bolts

material that can be effected by using smaller sized bar stock in the manufacture of bolts and nuts, as well as in the number of wrenches, is considerable.

Coarse-pitch Threads Give Ample Strength

Some manufacturers would adopt the S. A. E. standard width of head, but object to the fine threads that go with this standard. It can be mathematically shown, however, that if the coarser pitches of U. S. standard threads are used in S. A. E. standard nuts, the latter will still have ample strength, as compared with the bolt. A nut may fail from two common causes—from the threads stripping, and from the nut bursting.

In considering the strength of the threads to resist stripping, it is necessary that the depth of the nut be so established that the shearing strength of the threads will at least equal the tensile strength of the bolt. As the shearing strength of the steel is about 4/5 the tensile strength, the cross-section of the V-threads at the minor diameter of the bolt—that is, the area of the cylinder produced by stripping the V-threads at the root—should be to the cross-section area of the bolt in the ratio of 1 to 0.8. But since the top and bottom of the U. S. standard screw thread has a flat equal to ⅛ the pitch, only ⅞ of this cross-section of the thread is effective to resist shearing.

Referring to the accompanying illustration, H represents the thickness or height of nut, and d the nominal diameter of the bolt. From the preceding statements we have the following:

$$\frac{\pi d^2}{4} = \frac{4}{5} \times \frac{7}{8} \pi d H$$

or

$$0.25\,d = 0.70\,H \text{ and } H = 0.357\,d$$

This formula shows that, provided we have a nice fitting thread, if the thickness of the nut is approximately three-eighths the diameter of the bolt, it will be sufficiently strong to resist stripping the threads.

All threads, however, are not perfect so that the thread is not in shear but rather is in effect, a beam fixed at one end with the load some distance out. Consequently, allowing for poor workmanship and fit, we may say that a nut that is one-half instead of three-eighths the depth of the bolt diameter will be ample to resist stripping the threads.

Diameter of Nut to Resist Bursting Load

If we analyze the combined axial and radial pressures which cause a nut to burst, we can show mathematically what diameter of nut will be sufficient to withstand the forces that tend to burst it.

In the stress diagram shown at the right in the illustration, P represents the load on the nut and F the resultant radial pressure. The calculations show that

$$S = \frac{2f \times 0.7\,d \tan 30 \text{ deg.}}{12H} \times \left(\frac{2D^2 + d^2}{D^2 - d^2}\right)$$

in which

S = unit tensile stress in nut;
f = unit tensile stress in bolt;
d = diameter of bolt;
D = distance across flats; and
H = height of nut.

But the unit tensile stress f in the bolt should equal that in the nut, so that

$$1 = \frac{1.4d \tan 30 \text{ deg.}}{12H} \left(\frac{2D^2 + d^2}{D^2 - d^2}\right)$$

from which

$$D = d\sqrt{\frac{12H + 1.4d \tan 30 \text{ deg.}}{12H - 2.8d \tan 30 \text{ deg.}}}$$

We will now substitute numerical values for a one-inch diameter bolt in the foregoing formulas and derive the distance across flats (1) when the height of the nut H is equal to ½ d; and (2) when it is equal to d.

When H equals ½d:

$$D = d\sqrt{\frac{6 + 1.4 \times 0.5773}{6 - 2.8 \times 0.5773}} = 1\tfrac{1}{4} \text{ inches (nearly)}$$

When H equals d (present U. S. standard):

$$D = d\sqrt{\frac{12 + 1.4 \times 0.5773}{12 - 2.8 \times 0.5773}} = 1.11\,d \text{ or } 1\tfrac{1}{8} \text{ inches (nearly)}$$

The present U. S. standard for the distance across flats of nuts for 1-inch diameter bolts is 1⅝ inches, instead of 1⅛ inches.

The effect of friction, which will lessen the radial pressure F, has not been considered in arriving at these results, but this will have a tendency to reduce rather than increase the diameter of the nut. It will be seen that the short diameter of the nut should vary proportionately with the height H, and need be only ⅛ to ¼ greater than the nominal diameter of the bolt to prevent bursting.

Taking everything into consideration, the author is of the opinion that the width across flats, or the short diameter, and the height of the U. S. standard nut should be reduced to the sizes and standards now used and recommended by the Society of Automotive Engineers.

Electric Stop for Drawing Presses

By GEORGE W. WILDER

THE automatic electric stop described in this article was designed for use on Farrel roll-feed double-action presses which were employed in the production of screw shells such as are used on incandescent electric lamp bulbs and sockets. Each press was equipped with a gang or multiple die designed to blank and draw five shells at one stroke. In drawing the shells from 0.010-, 0.008- and 0.006-inch metal it occasionally happened that the bottom of a shell would be pushed through, as shown in Fig. 1. If the press was not stopped immediately when this occurred, the scrap shells would pile up on the die, frequently stopping the press. In such cases it was necessary to employ a long lever to release the dies. The dies were often broken or otherwise made unfit for future work as a result of this treatment.

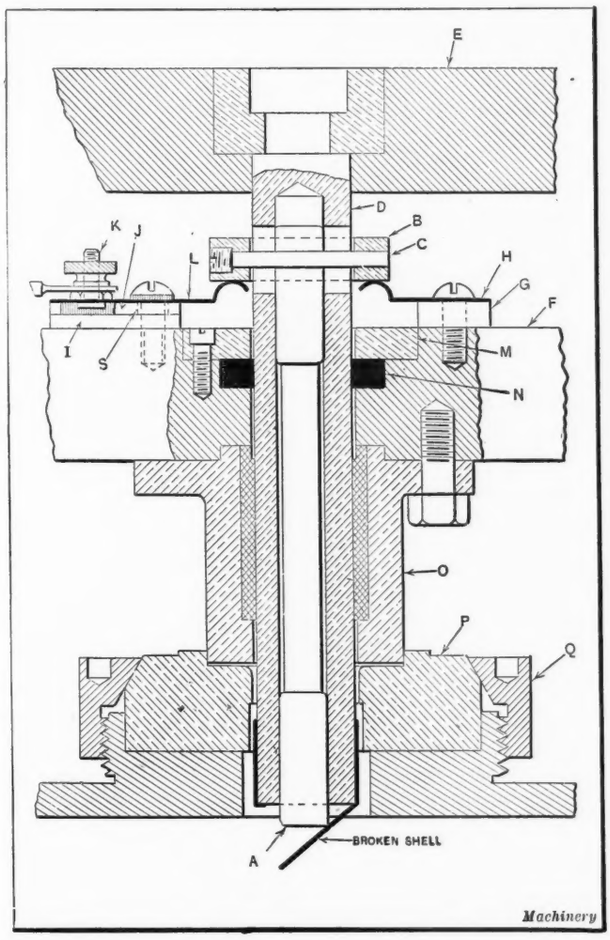


Fig. 1. Shell Blanking and Drawing Die equipped with Electric Stop

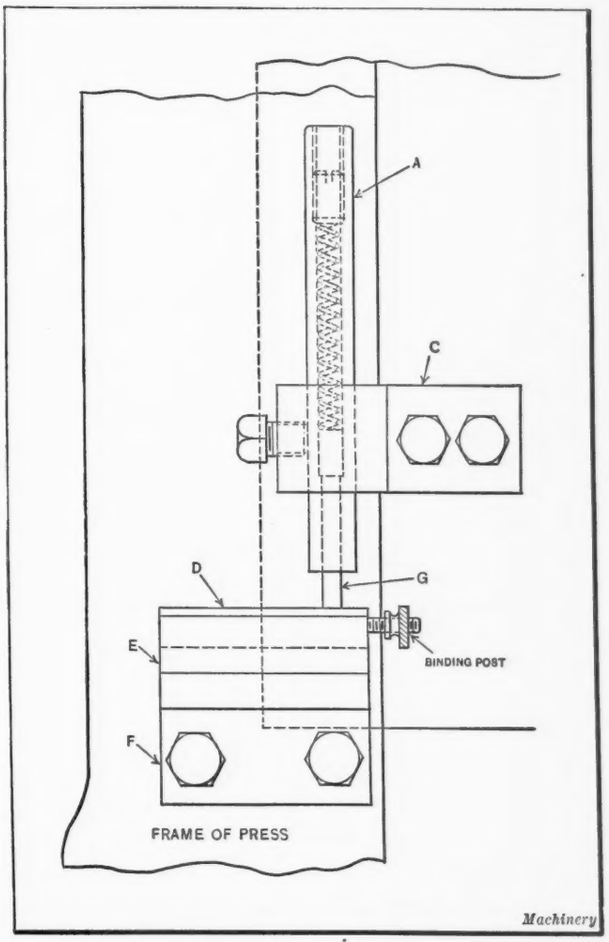


Fig. 2. Make-and-break Contact Device used with Press Stop

The electric stop eliminated this trouble by automatically stopping the press whenever the bottom of a shell pushed through, thus making it possible for one operator to attend four presses, where it had previously been necessary to have an operator for each press. An electric bell was also placed on the presses so that the operator's attention would be called to a machine as soon as it stopped. The construction of the automatic stop is as follows: A collar *B*, Fig. 1, is attached to each of the gang punches, and held to the push-pin *A* by a threaded dowel-pin *C*. This collar is designed to make contact between the brass springs *H* and *L* when the bottom of the shell is pushed through. Spring *H* is fastened to a brass block *G*, which is grounded on the press through the cutting punch-holder *F*. Spring *L* is prevented from grounding on the cutting punch-holder by the fiber blocks *J* and *I*. In order to prevent the screw that holds blocks *J* and *I* in place from making a short circuit between the punch-holder *F* and the contact *L*, an insulating bushing *S* was made of fiber and the screw inserted through this bushing. At the outer end of spring *L* is placed a terminal post *K* to which is fastened a wire. This wire, in turn, is connected in series with contacts *L* on the other four punches of the same press as indicated in Fig. 4.

Make-and-break Contact Device

Each press is also equipped with a make-and-break device, such as shown in Fig. 2. This device is provided with a plunger-holder *A* fastened to the blanking slide by the bracket *C*. When the slide is down within 1/16 inch of the bottom of the stroke, the spring-actuated plunger *G* makes contact with the brass plug *D* which is held in the fiber insulating block *E*. The fiber block is fastened to the frame of the press by the bracket *F*. By completing the circuit in this way, the electrically operated latch shown in Fig. 3 can be tripped only when the press is within 1/16 inch of the

bottom of the stroke. The plunger-holder *A* is adjustable, however, so that this distance can be decreased or increased, as the nature of the work may require.

The rod that connects the clutch key and treadle of the press was replaced by the tripping mechanism shown in Fig. 3. The clutch trip lever *U* is connected to the lever *W* by rod *V*. The treadle is also connected to lever *W* by rod *X*. When the treadle is pressed down by the operator's foot in starting the press, lever *W* is caught and held under roll *Y* on the electric latch. The clutch trip lever *U* is thus drawn down so as to clear the clutch key. When the latch is released, the levers fly up into the position shown by the dotted lines. The clutch trip thus engages the key and stops the press. If it is desired to stop the press without releasing the electric latch, all that is required is a slight pull on the hooked end of lever *W* which has an elongated hole in it that permits a lengthwise movement of about ⅜ inch.

Operation of Stop

The operation of the stop is as follows: Referring to Fig. 1, the metal is fed under punch *O* which cuts the blank and holds it in the drawing die *P;* drawing punch *D* then descends and draws the shell. If the bottom of the shell is not pushed out, the press continues to operate. The make-and-break device shown in Fig. 2 makes a contact when the blanking slide is down within 1/16 inch of the bottom of its stroke and continues to maintain this contact until the slide is moved upward about 1/16 inch on the return stroke. The press is so timed that although the drawing slide has a longer stroke, both slides start upward together and maintain the same speed for about ¼ inch of the upward stroke.

It is clear, then, that if the bottom of the drawn shell is not pushed out, the push-pin *A*, Fig. 1, will be held flush with the bottom of the drawing punch. Pin *A* must project from the punch end about ⅛ inch in order for collar *B* to make contact with springs *L* and *H*. As the drawing slide returns, the shell is stripped from the drawing punch by the bottom of the die *P*, and before the push-pin can drop so that it projects ⅛ inch below the punch, the contact made by the make-and-break device shown in Fig. 2 is broken. It requires a movement of only 1/16 inch to break the contact so that it is impossible to trip the press automatically until contact is made again at the end of the next downward stroke.

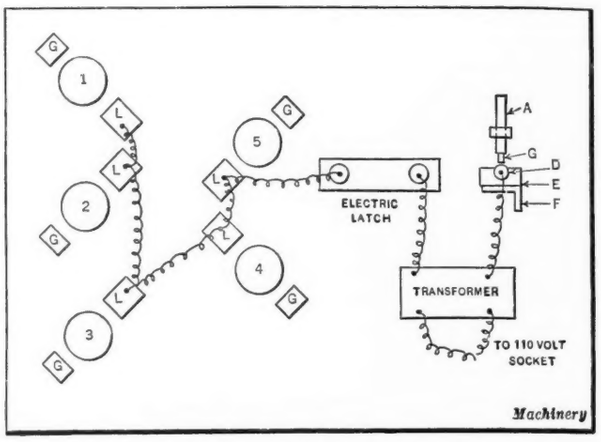


Fig. 4. Wiring Diagram of Electric Stop System on Gang Punch

If the bottom of the shell is pushed out on the drawing stroke, push-pin *A* is permitted to drop and the collar *B* to make contact with the springs *H* and *L*, which results in releasing the electric latch *Y* shown in Fig. 3. When the electric latch is released, the tripping levers on the press take the position shown by the dotted lines, causing the clutch trip to throw out the clutch and stop the press before another revolution is made. Some difficulty was experienced at first from the lubricant used on the metal being forced into the contacts and causing short circuits. A rubber washer *N*, Fig. 1, placed in the punch-block *F* prevented the lubricant from reaching the contact points and thus eliminated this trouble.

When the end of a roll of metal is reached, the contacts act in the same way as when the bottom of the shell is pushed out, and stop the press. The maximum production of 280,000 shells per day was reached and maintained by each of the four presses equipped with this stop, for a period of over four weeks. The presses were operated ten hours per day at a speed of 105 revolutions per minute. The average shutdown time for each press was one hour per day during the period of four weeks.

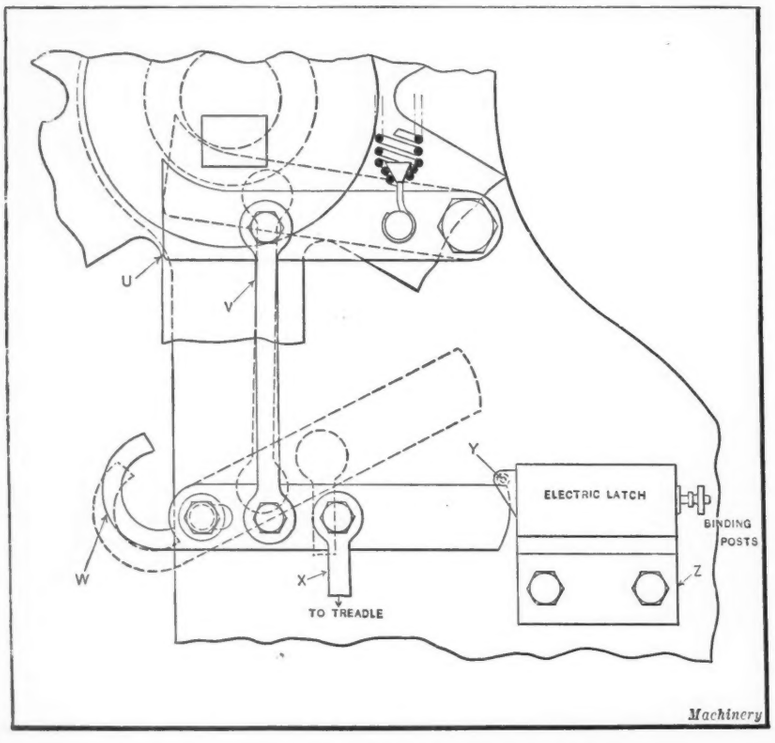


Fig. 3. Press Clutch Trip operated by Electric Latch

* * *

ELECTRICAL DEVELOPMENTS IN 1922

One of the tendencies in the electrical field in 1922 was the increase in the size of individual units for generating electric power. The maximum size reached for steam turbine generators was 62,500 K. V. A. The size of hydraulically driven generators was increased to 65,000 K. V. A., one of this size being built for the power developments at Niagara Falls. The largest transformers ever built are now under construction; these are 80,000 K. V. A. units for use in connection with 220,000 volts circuit. Oil circuit breakers of capacities greater than in the past have been designed, the largest so far built having an interrupting capacity of 600 amperes at 220,000 volts. Important advances have also been made during the year in the application of automatic control equipment. The largest fully automatic single-unit hydro-electric station built during the year consists of a 5000 K. V. A., 2300-volt, 60-cycle hydraulically driven generator. In the electric railway field the outstanding feature of the past year was the renewed interest in railway electrification.

Grinding Large Cylinders

ALTHOUGH the practice of grinding automobile engine cylinders is common, cylinders of large size, such as are used in stationary steam and gas engines and pumps are not generally finished in this way. However, in the cylinder regrinding plant of the Houpert Machine Co., Long Island City, N. Y., large stationary engine and pump cylinders are ground on the cylinder grinding machine illustrated in this article. The machine is made by Mayer & Schmidt of Germany, and the two views, front and rear, show it set up for regrinding a steam cylinder for a Worthington duplex hydraulic pump. These machines have a capacity for handling cylinders up to 32 inches diameter of bore and 80 inches long; the one shown is of medium size, however, being 20 inches in diameter and 44 inches long. For this job a grade 36 H crystolon wheel, 14 inches in diameter and ¾-inch face width was used.

The machine spindle has a planetary motion, and its radial feed and longitudinal traverse are automatically controlled. The machine differs from familiar types of American-made cylinder grinding machines, first, in regard to its massiveness and capacity, and, second, in the arrangement of the grinding head and work-table. The grinding head, or wheel-head, is moved on the ways of the machine, while the work is held stationary on the table, which is directly the reverse in the operation of American-made cylinder grinders.

A maximum throw of 1¼ inches is obtainable by adjustment of the eccentric. This important part of the machine consists of a long tapered arm *F*, Fig. 1, which is bolted to a sleeve contained within the wheel-head housing. The spindle that carries the grinding wheel extends through the arm and the sleeve, and is mounted on ball bearings. The sleeve inside the housing is located at an angle with the longitudinal center line of the machine, and the exterior surface of the sleeve forms an incline on which a wedge member is advanced to move the spindle radially. This adjustment is effected by turning the handwheel *C*, which revolves a large spur gear at the extreme end of the machine.

On the driving side of the machine, Fig. 2, near the flanged pulley will be seen the part of the wheel-head in which the eccentric driving gears are located. The longitudinal movement of the wedge member, to effect the total radial adjustment of the eccentric, is considerable, and since this wedge member drives the sleeve, it carries a long spur gear, the teeth of which remain in mesh with the driving gears, regardless of the longitudinal position of the wedge member.

Operation of the Cylinder Grinder

The work is first clamped to the table with the bore parallel to the center line of the spindle. Handle *A*, Fig. 1, is then operated to engage the clutch on the driving pulley (see Fig. 2), which drives the eccentric. The arm, extending to the clutch at the rear of the machine, may be seen at *A*, Fig. 2. The wheel-head is then advanced by means of handwheel *B*, Fig. 1, and the table adjusted laterally or vertically until the bore is centralized and the spark shows that the wheel is cutting equally on all sides. The adjustment of the table is effected by means of a crank-handle, and the position of each adjusting shaft is then secured by means of ratchets.

The adjustment for the eccentric throw is made through handwheel *C*, as previously mentioned, this adjustment being used only in setting up the machine. The wheel-head is advanced until the wheel extends nearly through the cylinder being ground, and there also the correct alignment of the cylinder and grinding machine spindle is assured by observing the sparks at various points.

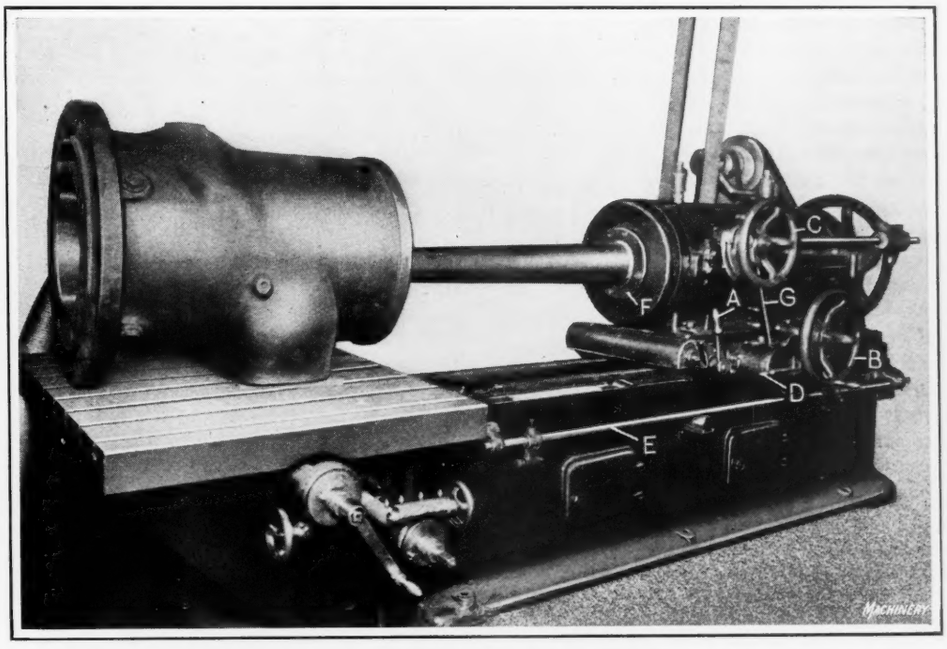


Fig. 1. Front View of Cylinder Grinding Machine with Movable Wheel-head and Stationary Work-table

While the wheel-head is at its extreme forward point, the front stop on the feed-rod *E* is set, as well as the amount of feed for the eccentric. The amount of feed for the eccentric per stroke is governed by a connecting-rod *G*, which extends up to a ratchet and a pawl in back of the handwheel *C*, where there is a graduated dial for setting the pawl to give the proper depth of cut in thousandths of an inch per traverse of the wheel-head. The automatic reversal of the wheel-head is accomplished by first engaging the clutch on the feed-shaft (located within the base) by means of lever *D*, so that as the head is fed to the rear, the rear stop on rod *E* can be set to contact with a finger on the wheel-head, at the end of the stroke. This moves the feed-rod and shifts the differential gears that drive the feed-shaft.

The differential gear-box is shown in the lower left-hand corner of Fig. 2, and the feed gears are driven by a separate belt from the countershaft. The wheel-head is thus provided with six rates of longitudinal feed, three of which are obtained by the cone pulley and two by the differential. The wheel-head rides on a flat way at the front of the machine, and on a V-way at the rear, which permits sufficient

lateral movement so that the wheel will follow the bore of the work without causing the spindle to be deflected. This is important, especially in a machine where a large moving member must maintain accurate alignment with the work.

On the driving side of the machine, Fig. 2, the cone pulleys from which the spindle is driven are shown. The bracket carrying the upper pulley shaft is constructed to serve as a belt tightener, the center-to-center distance of the two pulley shafts being changed by the nut shown between them. It will be seen that there are three spindle speeds available. The driving belt runs on a long drum as the wheel-head travels back and forth on the ways of the machine.

Conclusion

The operation of grinding large cylinders does not differ from that employed for automobile cylinder regrinding, with the exception that the machines operate on a slightly different principle. When cylinders are not too badly scored, four or five cuts will usually be sufficient to clean up the casting; in badly scored or worn cylinders it is sometimes necessary to take from ten to twelve cuts. The amount of eccentric feed per traverse may be 0.004 or 0.005 inch, that is, from 0.032 to 0.050 inch enlargement on the diameter for average work. It is difficult to give information regarding the depth of cut or the total amount of metal removed in a cylinder, but these figures will serve as a guide under average conditions, when extreme cases are not encountered.

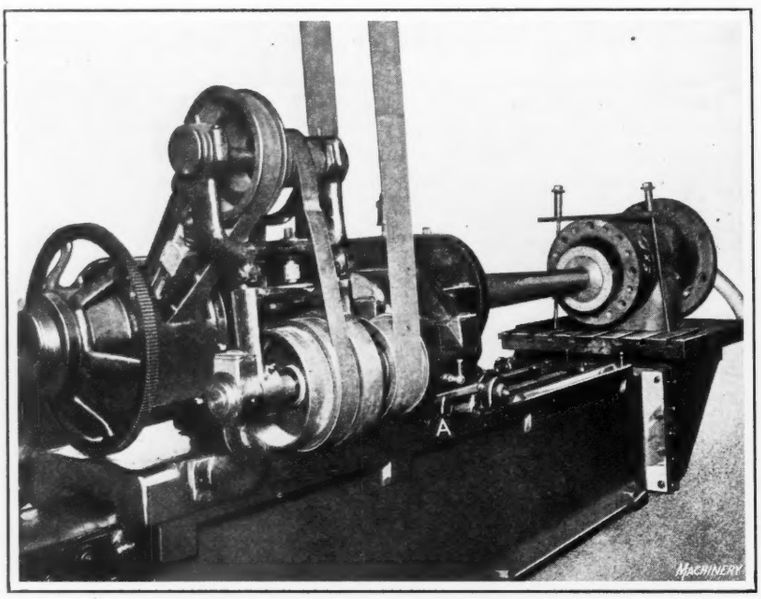


Fig. 2. View from the Rear or Driving Side of the Cylinder Grinder

* * *

POWER PRESS SAFETY CODE

The frequency of two of the most serious and most common types of industrial accidents should be greatly reduced through the application of two safety codes that have just been approved by the American Engineering Standards Committee. The Safety Code for power presses, and foot and hand presses, which has been approved as tentative American standard, is the first national safety code on this subject to be prepared in America. Heretofore each industry has tried to work out its own methods of preventing power press accidents, and in many cases individual plants have attempted to solve this problem out of their own experience without reference to what has been done in other plants.

This code consists of two parts—the first describing standard requirements, and the second consisting of a discussion of press hazards and protective methods and devices. The section on standard requirements covers such subjects as the location and installation of presses, feeding and removing material, making and setting of dies and operating rules. The second part of the code discusses general methods of protection, automatic and semi-automatic feeding devices, enclosing guards, hand tools, methods of removing materials, methods of forcibly removing hands, two-hand operating attachments, gage guards, and non-repeat and treadle disconnecting attachments.

ARRANGEMENT OF INFORMATION ON DRAWINGS

By HERBERT W. CABLE

The use of vellum paper sheets with printed titles, border lines, etc., for special tool drawings has become almost universal in large drafting-rooms. The lay-out or arrangement of the printed matter on the sheets is important, and the writer believes that the suggestions given in the following will be of value to those who have occasion to plan the arrangement of such sheets.

It is customary to designate each detail by a number enclosed in a small circle with an index line pointing to the detail on the assembly and detail drawings, and to place a corresponding number in the stock list, which is usually in the upper right-hand corner of the sheet. The numbers should be arranged on the assembly drawing in consecutive order and also in a straight line. This enables the workman to locate readily any detail on an assembly drawing. The various details should be known and referred to by their numbers and not by name.

There should be five columns in the stock list located in the following order: Detail; Amount; Material; Heat-treatment; Stock Size. Ample space should be provided in the last column for entering the catalogue number, size, and other necessary specifications. The heading only should be printed in the upper right-hand corner of the sheet. Along the right-hand margin line a series of dots should be printed to assist the draftsmen in spacing the lines. This method leaves more space available for the drawing than is the case when boxed in lines are printed down one side of the sheet.

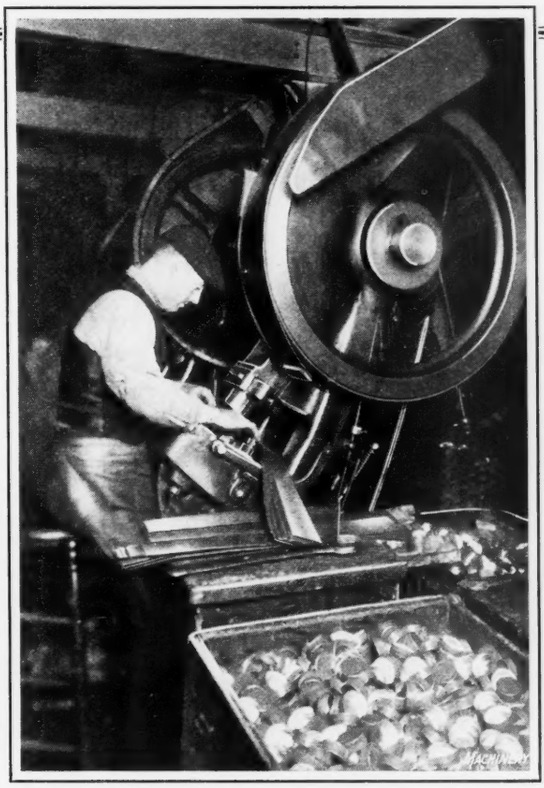
The complete stock list should be given on the assembly drawing whenever feasible, but on complicated drawings a separate sheet may be used. The style of type used should give the printed matter the appearance of hand lettering, and the whole title should present a uniform appearance. Space can be saved by abbreviating or entirely eliminating the word "Number," simply using the word "Part" instead of "Part Number." The title of the drawing can usually be divided into three parts, as follows: The part number and name; the operation number and name; and the name of the tool, jig, or fixture used. Space is usually provided for signatures and the date. The date given should be that on which the work is started.

* * *

The use of ball bearings for railway equipment has long been advocated by those engaged in the ball bearing industry. In Europe, experiments have been made to determine the value of ball bearings for railway equipment, and as a result of these experiments the S. K. F. Ball Bearing Works in Sweden recently received an order from the Swedish State Railways to supply complete ball bearing equipment for 170 railroad passenger cars. This order was placed as a result of ten-year tests conducted on the Swedish state railways.

Blank Diameters for Drawn Shells

By W. L. TRYON



DIEMAKERS and tool designers generally find it necessary to determine the diameter of blank required to draw round pieces of various shapes. Some prefer to use formulas in obtaining this dimension, while others find it more convenient to employ a graphical method. Formulas for finding the blank area and diameter of various types of shells will be found on pages 374 and 375 of January, 1915, MACHINERY and in MACHINERY'S book entitled "Die-making and Die Design." However, if the cross-section of a shell does not conform with any of those given in the references mentioned, the formulas or the graphical methods given in the following may be used. Those whose work is not checked by someone else will find it practicable to determine the diameter by one method and then check the result by the other. Both methods are based on the established rule that the area of the blank should equal the area of the shell. It is well to bear in mind that the area of the shell must include that of any holes punched in the shell.

Dividing the Shell into Segments to Find its Outside Area

Every round shell is made up of a series of elementary bodies such as disks, hollow cylinders, etc., the area of whose outside surface may be easily found by the rules of geometry. It is evident that the area of the outside surface of a shell is equal to the sum of the outside areas of its various elementary parts or segments. Therefore, the blank diameter may be obtained from the formula

$$D = \sqrt{\frac{S}{0.7854}}$$

in which D equals the diameter of the blank, and S the outside surface area of the shell.

Elementary segments of shells, together with formulas for finding the areas of their outside surfaces are given in Figs. 1 to 15, inclusive, in the Data Sheet opposite page 354. The actual calculations can be greatly simplified by the use of the tables on pages 48 to 59 in MACHINERY'S HANDBOOK, which give the circumferences and areas of circles. In actual use, all dimensions should be taken to the outside of the shell, although in the present article, for the sake of simplicity, the section of each shell has been considered as a line of no width.

Example of Use of Method

In order to illustrate the use of the formula method, assume that it is required to find the diameter of a blank for a shell having the cross-section illustrated in Fig. 16. The shell is first divided into the elementary segments *A*, *B*, *C*, *D*, etc., indicated by the dotted lines on the left side of the cross-section. The necessary dimensions of segment *A*, which conforms to that shown in Fig. 3, are d_1, which equals 1¾ inches, and $2h$, which equals 1 inch. From the tables of circumferences and areas of circles, previously referred to, it will be found that the area of a 1¾-inch circle is 2.4053 square inches, and the area of a 1-inch circle 0.7854 square inch. Therefore, according to the rule given in connection with Fig. 3, area $A = 2.4053 + 0.7854$ or 3.1907 square inches. In like manner, following the rules and using the tables as suggested, the areas of segments *B*, *C*, *D*, *E*, *I*, and *J* may be readily calculated, by using the formula applicable to each individual segment. To find the areas of segments *F*, *G*, and *H*, it is first necessary to determine several dimensions.

Finding the Dimensions for Segments F, G, and H

Referring to Fig. 17, in which line *LM* is an enlarged detail of the line governing segments *F*, *G*, and *H*, line *AD* is drawn through the centers from which the curved sides of segments *H* and *F*, Fig. 16, are struck. Next *AB*, Fig. 17, is drawn perpendicular to *BK* and extended to meet line *CD* which is drawn parallel to *BK* through center *D*. Then

$$(AD)^2 = (DE)^2 + (AE)^2 = 4 + 0.0156 = 4.0156 \text{ sq. inches}$$

$$(DC)^2 = (AD)^2 - (AC)^2 = 4.0156 - 1 = 3.0156 \text{ sq. inches}$$

$$BK = DC = 1.737 \text{ inches}$$

Also

$$\text{Tan } b = \frac{AE}{DE} = 0.0625 \text{ inch and } b = 3 \text{ degrees } 35 \text{ minutes}$$

$$\text{Tan } a = \frac{AC}{DC} = 0.5757 \text{ inch and } a = 29 \text{ degrees } 56 \text{ minutes}$$

Then

$$d = a + b = 33 \text{ degrees } 31 \text{ minutes}$$

$$h = DK \sin d = 0.276 \text{ inch}$$

$$KO = KD \cos d = 0.4169 \text{ inch}$$

and

$$x = LD - KO = 0.0831 \text{ inch}$$

The length of arc *KL* is found by the use of the following formula:

$$KL = MB = \frac{\pi r d}{180}$$

in which d is taken in degrees. Thus

$$KL = \frac{3.1416 \times 0.5 \times 33.517}{180} = 0.2925 \text{ inch}$$

Segment *G* in Fig. 16 conforms to the shape of the shell in Fig. 8, and it will be evident that f in the latter illustration is the same as *BK* in Fig. 17, which was found to be 1.737 inches. Also, using the reference letters in Fig. 8 in connection with Fig. 17,

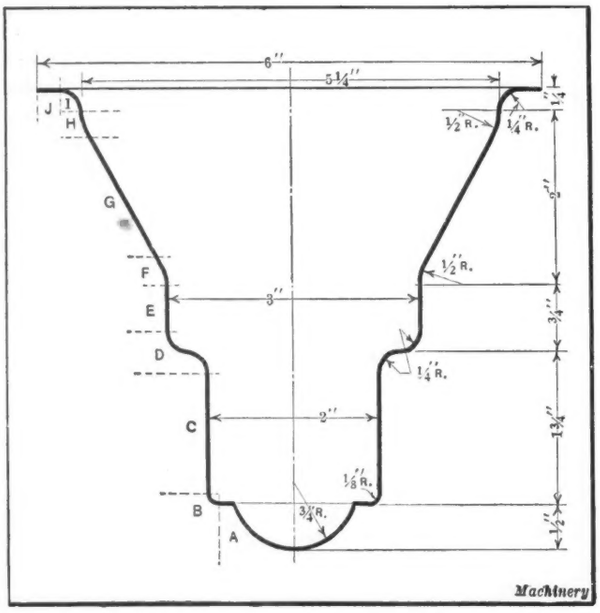


Fig. 16. Cross-section of Shell composed of Many of the Segments contained in Figs. 1 to 15 in the Accompanying Data Sheet

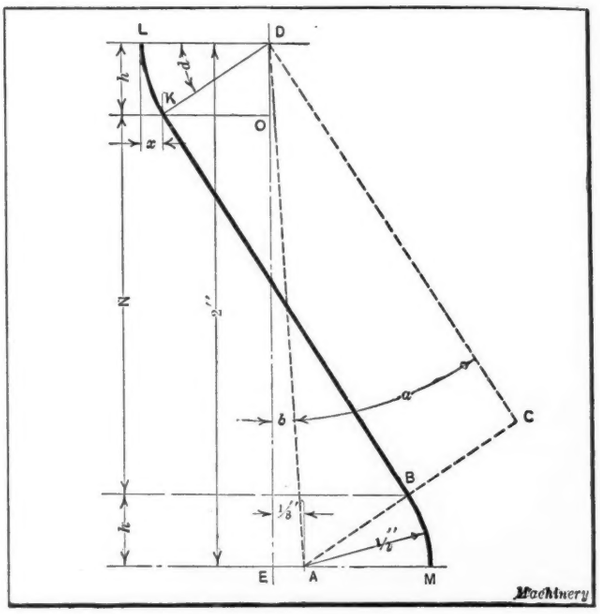


Fig. 17. Lay-out for determining Certain Dimensions required in calculating the Areas of Segments F, G, and H, Fig. 16

$$\frac{d + d_1}{2} = \frac{(3 + 2x) + (5.25 - 2x)}{2} = 4.125 \text{ inches}$$

and

$$f \times \frac{d + d_1}{2} = 1.737 \times 4.125 = 7.165 \text{ inches}$$

For the case in Fig. 8, it is stated, under the heading "General Rule" that the area of the segment equals the numerical value of the circumference of a circle having a diameter equal to the product of this last formula. Therefore, to find the area of the segment in question, it is necessary to look up the circumference of a circle whose diameter is 7.165 inches As the circumferences in the tables referred to are only given to three places, it is necessary to interpolate for the fourth place. It will be found that the circumference of a 716-inch diameter circle equals 2249.38 inches, and that of a 717-inch diameter circle 2252.52 inches. The circumference of a circle 716.5 inches in diameter equals the circumference of a circle 716 inches in diameter plus one-half the difference between the 716- and 717-inch circles, or $2249.38 + (0.5 \times 3.14) = 2250.95$ inches. As the diameter in question is 7.165 inches instead of 716.5 inches, the corresponding circumference is $2250.95 \div 100 = 22.509$ inches.

In using the tables of circumferences and areas, it should be remembered that for every digit the decimal point is moved in the diameter, the decimal point moves one digit in the corresponding circumference and two in the corresponding area.

Summarizing the Calculations

Having obtained the necessary dimensions for calculating the areas of segments *F*, *G*, and *H*, it is now possible by following the rules for Figs. 1 to 15 and using the tables of circumferences and areas, to determine the areas of all the segments constituting the shell in Fig. 16. The different areas may then be tabulated as follows:

Area of segment	*A* (Fig. 3)	= 3.1907 square inches
	B (Fig. 10)	= 1.1777
	C (Fig. 7)	= 8.6394
	D (Fig. 15)	= 6.1685
	E (Fig. 7)	= 4.7124
	F (Fig. 13)	= 2.8086
	G (Fig. 8)	= 22.5095
	H (Fig. 12)	= 4.7721
	I (Fig. 11)	= 6.7011
	J (Fig. 1)	= 2.3071
Total area of shell		= 62.9871 square inches

Referring to the tables of the circumferences and areas of circles, it will be found that the diameter of a circle having an area of 62.9871 square inches is approximately 8.955 inches and this, of course, is the required blank diameter of the shell illustrated in Fig 16. Any other round shell may be treated in a similar manner.

Determining Blank Diameters by Graphical Methods

Graphical methods of solving the diameters of blanks for shells of various shapes will now be presented, together with proofs. Taking the common shell shown in Fig. 18 as the first example, the procedure is as follows: With line *AB* as a radius and *A* as a center, draw arc *BC*. Then draw arc *CE*, with *D* as a center. This arc intersects line *AB* extended, at point *F*. The radius of the blank required to produce this shell is *AF;* this may be proved by the following calculations: Assume that $AB = \frac{d}{2}$ and $AD = h$. Then the area of the bottom of the shell $= \frac{\pi d^2}{4}$ and the area of the cylindrical segment $= \pi dh$. The latter equation is the same as that given in connection with Fig. 7. Adding the two formulas together, the total area equals

$$\pi\left(\frac{d^2}{4} + dh + h^2 - h^2\right) = \pi\left[\left(\frac{d}{2} + h\right)^2 - h^2\right]$$

In the triangle *ADF*,

$$(AF)^2 = (DF)^2 - (AD)^2 = \left(\frac{d}{2} + h\right)^2 - h^2$$

Substituting $(AF)^2$ for its equivalent value in the formula for the total area, we have:

$$\text{Total area} = \pi(AF)^2$$

As this area equals the area of the blank, if *R* is taken to represent the blank radius, then

$$\pi R^2 = \pi(AF)^2 \text{ and } R = AF$$

To find the radius of a blank for the shell in Fig. 19 the procedure is as follows: With radius *AB* draw arc *BC*. Then with radius *DC* draw arc *CE*, cutting line *AB* extended, at point *F*. The radius of this blank is *FG*, as is proved in the following:

Let $AD = H$, $AB = \frac{d}{2}$, *and* $AG = h$. Then

$$AC = \frac{d}{2} \text{ and } DC = H + \frac{d}{2}$$

$$(AF)^2 = \left(H + \frac{d}{2}\right)^2 - H^2 = dH + \frac{d^2}{4}$$

$$(FG)^2 = (AF)^2 + (AG)^2 = dH + \frac{d^2}{4} + h^2$$

Multiplying each side of the equation by π, we have:

$$\pi\,(FG)^2 = \pi\left(dH + \frac{d^2}{4} + h^2\right)$$

This formula will be found to equal the sum of the formulas given in connection with Figs. 3 and 7, and may be reduced to $\pi(FG)$. This proves the radius of the blank to be FG. Fig. 20 gives examples of other problems which may be constructed and proved in a similar manner.

The construction for finding the blank diameter of the shell in Fig. 21 is as follows: With D as a center, draw arc CE, cutting line AB extended, at point F. Then chord CF is the radius of the blank. Proof:

$$(AF)^2 = h^2 - (h - r)^2 = 2rh - r^2$$

$$(CF)^2 = (AF)^2 + (AC)^2 = 2rh \text{ and } \pi\,(CF)^2 = 2\pi rh$$

As $2\pi rh$ is the area of the shell, according to the formula given in connection with Fig. 5, line CF is the radius of this particular blank.

Shells with Elliptical Cross-section

Fig. 22 shows a shell of an elliptical cross-section. The construction necessary for solving the blank diameter by the graphical method is first to extend AB to C, making $BC = AJ$. Then draw a semicircle ADC with the center at H, and draw BE of any length perpendicular to BK, and BF of such a length that $\frac{BF}{BE} = \frac{19}{16}$. Next draw FD and EG parallel. Then BG is the radius of the blank. Proof:

$$\frac{BG}{BD} = \frac{BE}{BF} = \frac{16}{19} \text{ and } BG = \frac{16 \times BD}{19}$$

Let $AJ = d$ and $BK = h$. Then

$$AB = \sqrt{\frac{d^2}{4} + h^2} \text{ and } BC \times AB = d\sqrt{\frac{d^2}{4} + h^2}$$

By construction

$$(BD)^2 = BC \times AB = d\sqrt{\frac{d^2}{4} + h^2}$$

$$(BG)^2 = \left(\frac{16}{19}\right)^2 \times d\sqrt{\frac{d^2}{4} + h^2} = \frac{256}{361} \times d\sqrt{\frac{d^2}{4} + h^2}$$

In connection with Fig. 6 it is stated that the area of an elliptical shell equals $2.222d\sqrt{h^2 + \frac{d^2}{4}}$, and if R is the radius of the blank, then

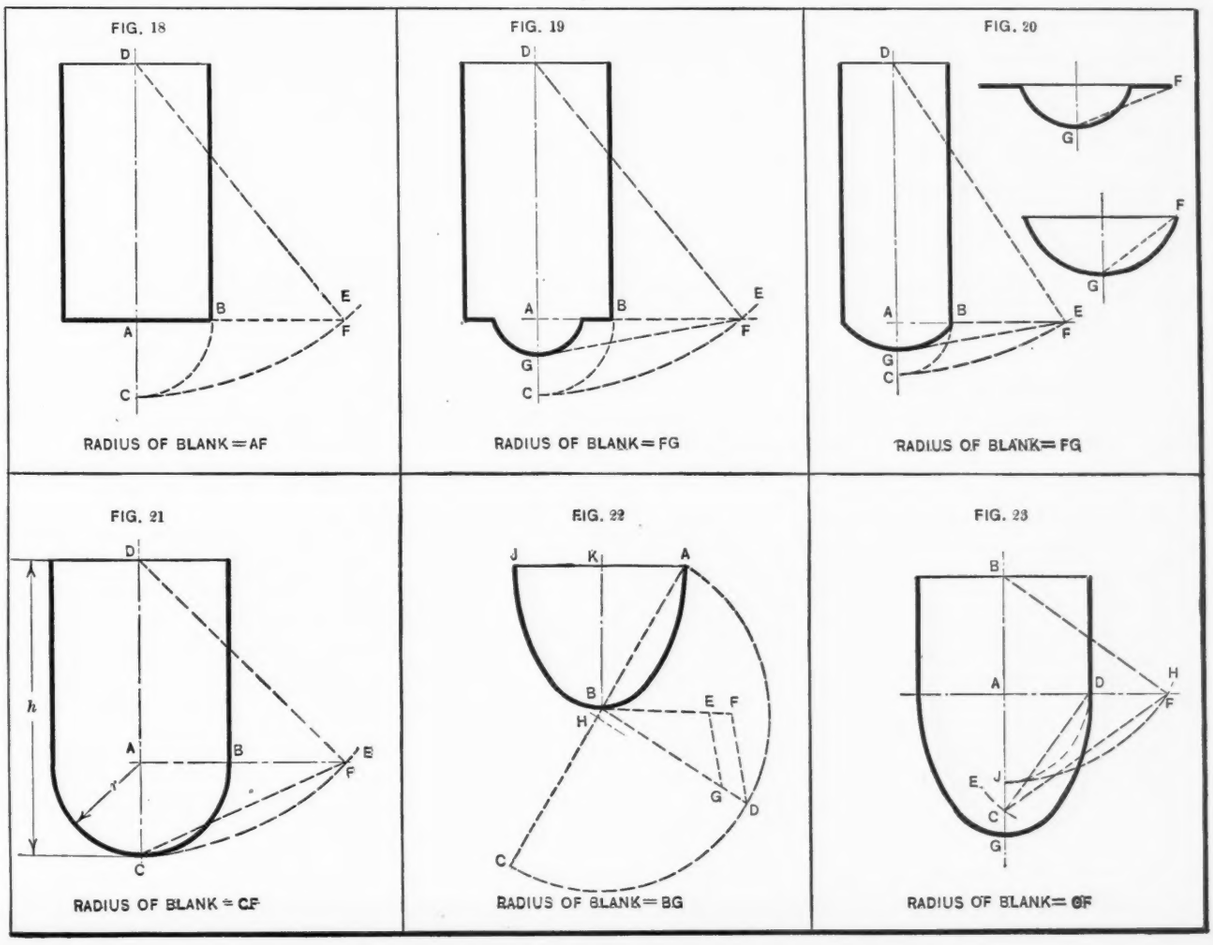
$$\pi R^2 = 2.222d\sqrt{h^2 + \frac{d^2}{4}}$$

and

$$R^2 = \frac{2.222d}{3.1416}\sqrt{h^2 + \frac{d^2}{4}} = \frac{256d}{361} \times \sqrt{h^2 + \frac{d^2}{4}} \text{ (approximately)}$$

By referring to the equation in the foregoing for $(BG)^2$ it will be obvious that $R = BG$.

If a shell has an elliptical bottom and a cylindrical body, like that illustrated in Fig. 23, proceed as follows to find the blank radius: Draw arc EC with D as a center and a radius equal to the radius of blank which would be required for the bottom alone; this is found as described in connection with the foregoing example. Then with A as a center draw arc DJ, and with B as a center, draw arc JH cutting



Figs. 18 to 23. Graphical Method of finding Radius of Blank for Different Shaped Shells

line AD extended, at point F. Length FC is the radius of the blank required for the entire shell. Proof:

Let $AB = h$ and $AD = AJ = r$. Then

$$BF = BJ = r + h$$

$$(AF)^2 = (r+h)^2 - h^2 = 2rh + r^2$$

$$(AC)^2 = (DC)^2 - r^2 \text{ and } (AF)^2 + (AC)^2 = 2rh + (DC)^2$$

$$(CF)^2 = (AF)^2 + (AC)^2 = 2rh + (DC)^2$$

$$\pi (CF)^2 = 2\pi rh + \pi (DC)^2$$

As $2\pi rh$ is the area of the cylindrical segment and $\pi (DC)^2$ the area of the bottom segment, CF is the radius of the blank required for the entire shell.

Shell Having Two Cylindrical Segments

For shells with more than one cylindrical body segment and various bottom segments, it is first necessary to find a shell of a shape like one previously considered, having an area equivalent to that of the shell for which the blank radius is being determined. Then by finding the radius of the blank for the equivalent shell, the radius of the required blank can be found. The diameter of the bottom segment in question should be considered the diameter of the equivalent shell, and the height of the latter should be found by adding the heights of segments of this diameter which would have areas equal to the segments of the shell under consideration.

Taking the shell in Fig. 24 as an example, the diameter of the equivalent shell would be AC, line ABC indicating a standard bottom. The body part of the equivalent shell would follow lines $ACFR$. It will be evident that the cylindrical section $ACEG$ is common to both shells. Now, on the center line locate point K at a height from J equal to CE. Then bisect EH by drawing LM perpendicular to this line, and lay out EO on line CF equal to EH. Then draw KO, which, extended, cuts LM at N. Line LN is the height of the cylinder of diameter AC having an area equal to that of ring IH. Next so locate P on the center line that KP equals LN.

For the cylinder $HIQS$, extend IQ and locate T on the equivalent shell section so that GT equals IQ. Then draw KT continuing to the extension of line IQ and intersecting it at U. Line IU is the height of a cylinder of diameter AC which has an area equal to the cylinder of $HIQS$. Therefore, locate V on the center line a distance above P equal to IU, and draw FR perpendicular to FC through point V. Then shell $ABCFR$ will have the same area as the original shell, and consequently will require the same blank diameter. The radius of this blank is equal to BX, as will be apparent by referring to Fig. 19. The proof of this method can best be given after a discussion of the methods of finding segments of a given diameter having areas equivalent to the segments shown in Figs. 7 to 15, inclusive.

Fig. 25 gives a segment of diameter d and height h. To find the height H of a segment of diameter D, which will have the same area as the given segment, first locate point B where line AC cuts the center line, and draw BK through intersection J, extending the line until it cuts CF extended. Finally draw KN parallel to AC, which will produce length H. As BGJ and BCK are similar triangles,

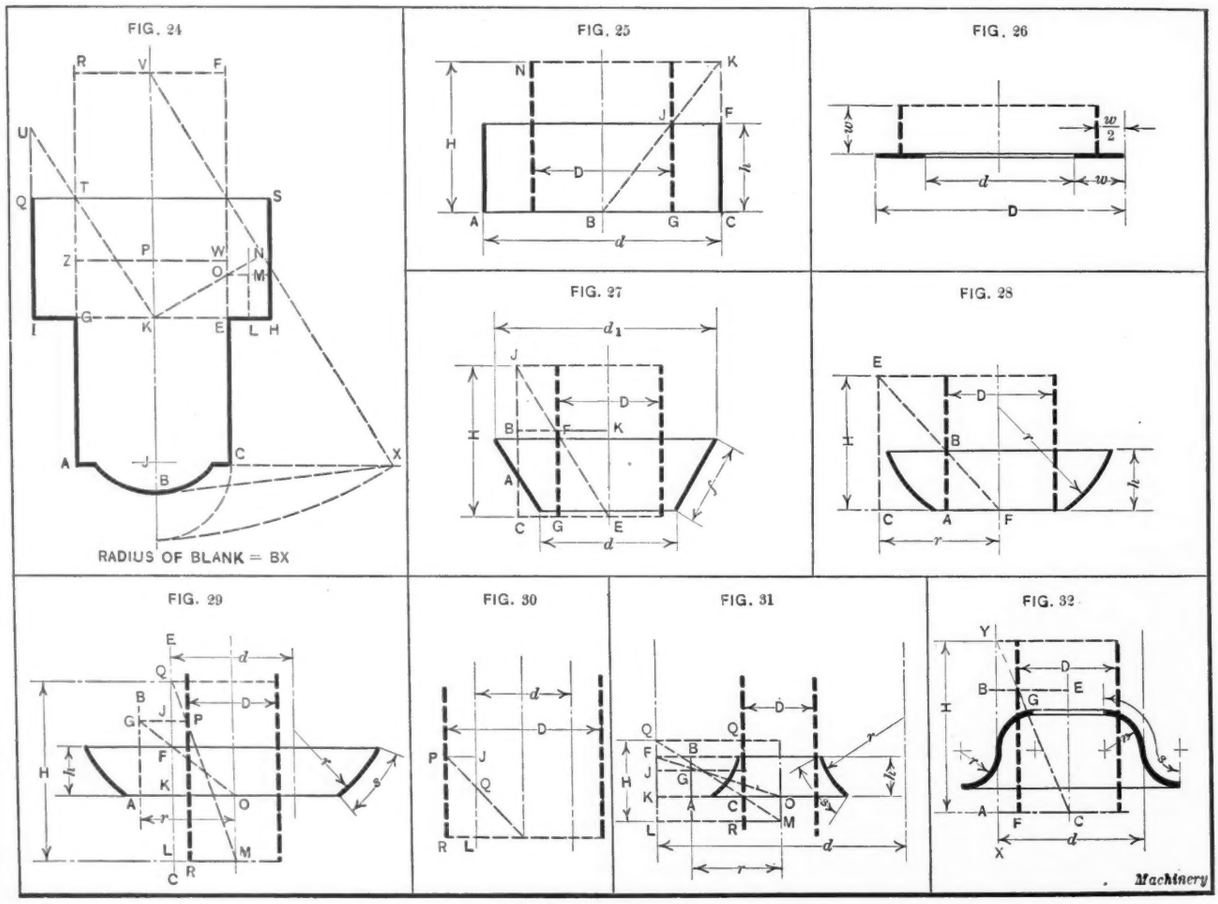
$$\pi HD = \pi hd$$

Therefore, the two cylindrical segments have the same area.

Fig. 26 shows the method of finding the dimensions of a cylindrical segment having the same area as a ring. The area A of this ring may be found by the following formulas:

$$A = \frac{\pi}{4} \times (D^2 - d^2) = \pi w (d + w)$$

The second of these two formulas obviously may also be used for finding the area of the dotted cylindrical segment. In finding the area of a complicated shell, this ring segment would be converted into another cylindrical segment having



Figs. 24 to 32. Graphical Method of finding the Diameter of a Cylindrical Segment that will have the Same Surface Area as a Segment of Some Other Shape

a diameter equal to that of the equivalent shell, by means of the method used for the case illustrated in Fig. 25. Now, referring back to Fig. 24, cylinder *WFRZ* has the same area as cylinder *HIQS*, and cylinder *EGZW* has the same area as ring *IEGH*, as previously indicated.

Finding the Heights of Cylindrical Shells of a Certain Diameter having Areas Equal to Various Segments

All shells may be solved in the same manner as that outlined for Fig. 24, and for this purpose the construction of cylindrical segments of a given diameter D equivalent to the segments shown in Figs. 8 to 15, inclusive, will now be given. A segment of the same shape as that in Fig. 8 is shown in Fig. 27. Intersection A of line BC is at the middle of the segment side f, this side being bisected by line BC. The latter must be equal in length to f and drawn parallel to the center line. Then draw BK and CE perpendicular to the center line, intersecting the cylinder of diameter D at points F and G, respectively. Finally, draw EF and extend this line and CB until they intersect at J. Line CJ is the height H of the cylindrical segment of diameter D which has an area equal to that of the segment shown by the full lines. Proof:

$$FG = BC = f$$

$$CE = \frac{d_1 + d}{4} \text{ and } \frac{H}{f} = \frac{d_1 + d}{2D}$$

$$HD = \frac{f\ (d_1 + d)}{2} \text{ and } \pi HD = \pi f \times \frac{d_1 + d}{2}$$

By referring to the formula given in connection with Fig. 8, it will be seen that the areas of both the full-line and equivalent segments are equal.

In Fig. 28, which shows a segment identical with that in Fig. 9, A and B are the points where the bottom and top edges of the given segment cut the required cylinder of diameter D. First draw CE parallel to the center line and at a distance from it equal to r. Then draw FB and extend until it meets CE. Then the line CE is the height H of the cylindrical segment of diameter D having an area equal to that of the given segment. Proof:

$$\frac{H}{h} = \frac{2r}{D}$$

$$DH = 2rh \text{ and } \pi DH = 2\pi rh$$

To find graphically the length of a cylindrical segment having the same area as the segment in Fig. 29, which is similar to that in Fig. 12, first draw line AB parallel to the center line and at a distance r from it. Then through point F, where CE intersects the upper edge of the segment, draw OF and extend it until it intersects AB at G. Next draw GP parallel to AO, intersecting CE at J; so locate the bottom edge of the dotted segment that KL equals s; and then draw MP and extend it until it intersects CE at Q. Then LQ is the height H of the cylindrical segment equal in area to the segment indicated by the full lines. Proof:

$$r : \frac{d}{2} = AG : KF \text{ and } JK = AG = \frac{2rh}{d}$$

As $KL = s$,

$$PR = JL = \frac{2rh}{d} + s$$

Also,

$$PR : \frac{D}{2} = QL : \frac{d}{2}$$

Then

$$PR = \frac{HD}{d} = \frac{2rh}{d} + s$$

and

$$\pi HD = \pi\ (2rh + ds)$$

This proves that the area of the given segment is equal to that of the cylindrical segment of diameter D and height H. The segment shown in Fig. 10 is solved in the same manner. Fig. 30 shows the construction to be followed when D is greater than d. In this case QL would again equal H.

To find the area of the shell in the diagram Fig. 31, proceed as follows: Draw AB parallel to the center line and at a distance r from it; draw OF to intersect AB at G; draw GJ parallel to CO; locate L so that JL equals s; draw LM parallel to CO; cutting the center line and cylinder of diameter D at R; and finally draw MC, extending it to intersect FL extended, at Q. Line LQ is the height H of the cylindrical segment of diameter D equal in area to the segment shown by the heavy solid lines. Proof:

$$r : \frac{d}{2} = AG : FK \text{ and } JK = AG = \frac{2rh}{d}$$

$$JL = s \text{ and } CR = s - \frac{2rh}{d}$$

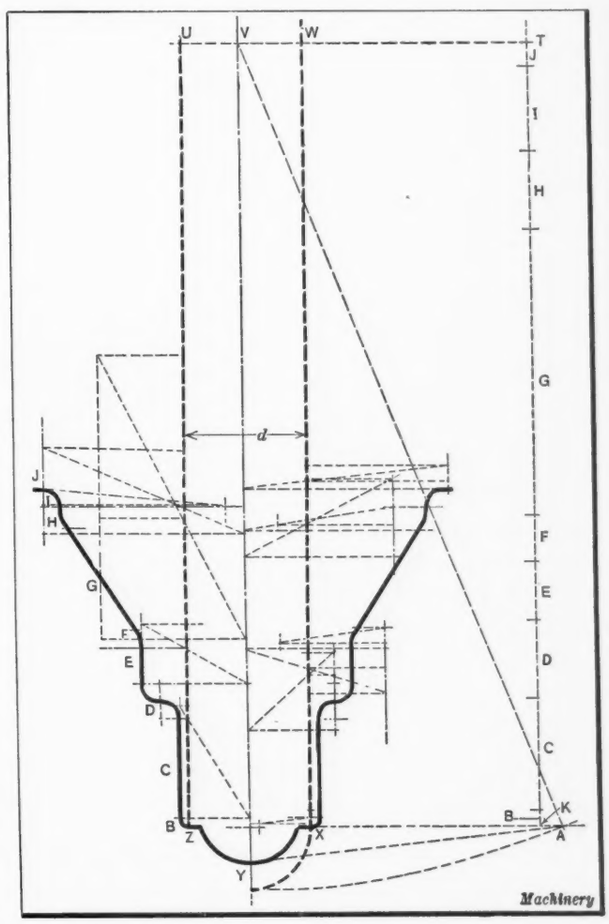


Fig. 33. Method followed in the Graphical Determination of the Diameter of Blank required for a Given Shell

Also

$$LQ : CR = \frac{d}{2} : \frac{D}{2} \text{ and } LQ = H = \frac{d}{D} \times \left(s - \frac{2rh}{d} \right)$$

$$\pi HD = \pi(ds - 2rh)$$

This proves that the area of the dotted cylinder is the same as the given segment, as will be apparent by referring to the formula given in connection with Fig. 13. The segment of the shape illustrated in Fig. 11 could be solved by the same method.

For the segment in Fig. 32, lay out on line XY a distance AB equal to s, which, in turn, equals πr. Then draw AC and BE perpendicular to the center line and cutting the cylinder of diameter D at F and G, respectively; next draw CG, extending it to its intersection with XY. Then AY is the height H of the cylindrical segment of diameter D. This is proved as follows:

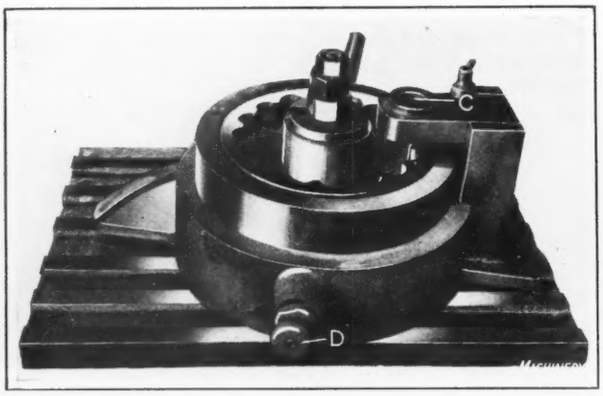


Fig. 1. Ratchet Ring located in Fixture ready for drilling

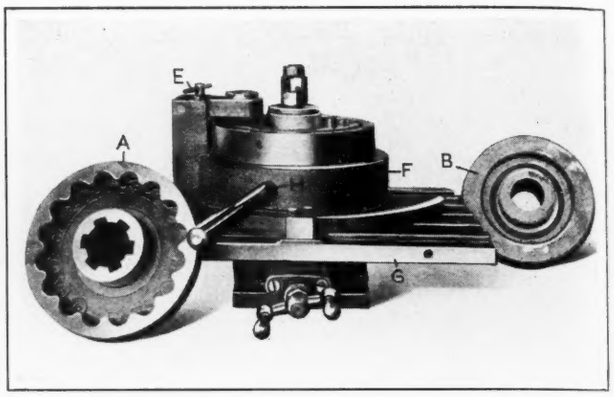


Fig. 2. Finished Ratchet Ring, Fixture, and Rough Forging

$$FG = AB = s = \pi r \text{ and } FG : AY = \frac{D}{2} : \frac{d}{2}$$

$$H = AY = \frac{\pi r d}{D} \text{ and } HD = \pi r d$$

Then

$$\pi HD = \pi^2 r d$$

This proof will be apparent by referring to the formula given in connection with Fig. 14. The construction and proof are also the same for the segment shown in Fig. 15.

Fig. 33 shows a graphical method of finding the radius of blank for the shell indicated by the heavy full line. This cross-section includes most of the segments dealt with, and is an example intended to make clear the use of the constructions employed in the foregoing for finding the blank radius of a complete shell. The equivalent shell will have the bottom *XYZ* and a diameter *d*. The various heights of segments of diameter *d* which are equal in area to segments *B*, *C*, *D*, *E*, etc., are then found by the foregoing methods and summed up on the line *KT* which is drawn outside the figure to avoid confusion. The sum of all the heights of cylinders of diameter *d* having areas equal to the various segments from *B* to *J*, inclusive, equals *KT*. From *T* a line *TU* is drawn parallel to *ZX*. The blank radius of the equivalent shell *UWXYZ* can then be readily found. This radius is *AY*, as will be understood by reference to Fig. 19.

* * *

RATCHET AND PAWLS FOR GEARLESS DIFFERENTIAL

By ROBERT MAWSON

The fixture shown in Figs. 1 and 2 is employed in machining the ratchet ring *A*, Fig. 2. The small fixtures shown in Fig. 3 are used in performing radius-grinding operations on the ends of the pawls which engage the teeth of the ratchet ring. The first operation in machining the ratchet ring is boring the center hole. One of the rough forgings is shown at *B*, Fig. 2. After the central hole is bored, the forging is faced and turned to the finished size. The six splines, as shown in the finished ratchet ring *A*, are then broached. The forging is next placed in the jig or fixture as indicated in Fig. 1.

The work is located in this fixture by the finished central hole, and is held securely in place by means of a nut and washer while holes are drilled in the forging to form the bottom of the ratchet teeth, the drill being guided by bushing *C*, Fig. 1. The upper part of the jig which holds the work is indexed to each drilling position. Accurate indexing is insured by pin *D* which fits into accurately spaced holes in the revolving part of the jig.

After the drilling operation, the jig with the work still in place is fastened to the table of a vertical milling machine equipped with an end-mill. The pin *E*, Fig. 2, is next withdrawn to permit the fixture body *F* to be pivoted on a pin held in table *G*. The pin in table *G* is not shown, but it is so positioned that the milling cutter will round the ends of the ratchet teeth to the required radius when base *F* is revolved or swung back and forth about its axis. The handle *H* is used to rotate or pivot the base *F* on table *G* while rounding the ends of the ratchet teeth. As the work is indexed about the same center for both the drilling and milling operations, a high degree of accuracy is obtained

Fixtures for Holding the Pawls

The pawls used in the ratchet ring are also made from forgings, one of the finished pawls being shown at *J*, Fig. 3. The first operation on the pawl is that of turning the trunnion ends *K* and facing the sides of the shank at *L*. The pawl is next ground on the end that is in contact with the ratchet teeth when it is assembled in the complete unit. The fixture shown at *R* is used to hold the pawl for the first radius-grinding operation. In this operation, the work is located by means of the turned trunnions and is held securely in place by the set-screw *W*. The grinding is done on a Landis grinder, the centers of the machine being placed in the centers in the ends of trunnions *K*. The grinding wheel on the machine is brought into contact with surface *V* which is ground to the correct radius by rocking the fixture on centers by means of handle *U*.

The forging is next placed in the fixture shown at *M*. The conical pointed screws *Y* are used to locate the work from the centers *K*. Pointed set-screws *N* are then tightened down on the work to hold it in place. The fixture is held between the centers of the grinding machine which enter centers *O* of the fixture. The grinding wheel is correctly set for grinding the ends of the pawl to the required shape or radius. It has been found that this simple method of holding the work results in the production of accurate pawls that are uniform with respect to their important bearing surfaces.

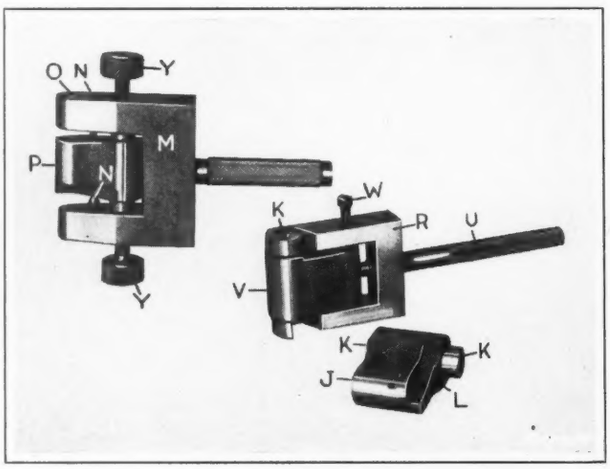


Fig. 3. Fixtures used in Radius-grinding Operations on Ratchet Pawls

The British Metal-working Industries

From MACHINERY's Special Correspondent

London, December 12

NOW that the general election is past, business will, it is hoped, again resume the forward movement which political events have had a tendency to check. With the end of the year approaching, we can look back on what will always be regarded as one of the most trying periods in industrial history. At the end of 1921, employers thought we had reached the turn of events, as a perusal of the trade reviews for that period show. Instead of that, during the first six months of 1922, it was simply a case of marking time, and in that period local firms have had to resort to expedients in the form of economy, which were never before necessary in their history. Since July, however, there has been a gradual picking up in all industries, and some firms are quite busy. Unfortunately the stage has not yet been reached when works can employ a full working force, and while no definite figures are available, it is safe to say that the average engineering shop is running with one-half the normal force.

The Machine Tool Industry

The position of the machine tool industry, beyond a better tone of inquiry, shows little change. A greater number of sales are undoubtedly being made, and the outlook as a whole is more promising. A common experience is that a prospective buyer may have work sufficient to justify the installation of new machines, but the fear that the current activity will not continue causes him to hold back in placing an order. Competition is very keen, and makers have to quote on an exceptionally small margin in order to get business. To what extent the position has improved may be gathered from the fact that a well-known maker recently booked an order for seven machines of a type which for nearly two years has been in only limited demand.

Second-hand machines still bring good prices, as is shown by the fact that a Clyde firm recently disposed of twenty lathes (to be substituted by automatics), all of which were sold within a week at good prices. However, the idea is beginning to prevail that some things are dear at any price and nothing is cheap if it is not precisely what is wanted. The desire to obtain the largest weight for the smallest price is giving way to a recognition that the requirements of a balanced plant and modern production cannot be met except by a machine that is exactly suitable.

This view has reacted also upon machine tool makers, the more progressive of which, such as John Lang & Son, Johnstone, and Dean, Smith & Grace, Ltd., Keighley, have taken advantage of the depression to redesign their lathes. This step is also one of the results of the war. During that strenuous manufacturing period, lathes were working to their limit, operated very largely by those who, previous to the war, had never seen a lathe. These circumstances really afforded a good opportunity for accumulating valuable data and information on the performance of machines under the worst working conditions, and the lessons learned have been embodied in new designs.

Ton prices, although not very accurate for purposes of comparison, serve well enough in a general statistical sense. An all-around price per ton (2240 pounds) for lathes would be about £140 (about $630, present exchange), planers £84 ($378), radial drilling machines £125 ($562), grinding machines £230 ($1035), shapers £110 ($495).

The small tool trade is usually one of the first to reflect any improvement in the engineering field as a whole, and makers report the upward strike of the trade curve well maintained. Foundries are also busier and are both giving and taking an increased amount of business.

Exports and Imports

Exports of machine tools for October rose, as compared with the previous month, from 883 to 1525 tons, and from £115,895 to £158,371 in total value. The improving tendency from the lowest point of the depression has now continued for three months. Imports have also risen slightly —from 231 to 311 tons and from £34,410 to £41,312 in total value. The values per ton have fallen—on exports from £131 to £104, and on imports from £149 to £133. The ton price of imports for the month shows the wide variation of from £74 per ton for tools imported from Germany, to £203 per ton for those imported from the United States.

The Railway Field

Railway requirements are likely to loom large in the future. Plans are being made, under government guarantee, in connection with unemployment relief, for extensive developments in the railway field. The Underground Railways contemplate a total expenditure of £17,000,000 on schemes to be carried through in conjunction with the government proposals for dealing with unemployment. With government encouragement and the end of the complications and troubles resulting from the regrouping that has been going on, there is no doubt that the railways will now enter more freely into the market than they have done during the last few years. Overseas prospects in the railway field are most encouraging; several orders for locomotives have been placed, the estimated total value of which is £250,000, and other substantial orders are in prospect.

The Automobile Industry

With regard to the automobile industry, it is of special interest to learn that there are signs of a real revival in the demand for high-grade heavy commercial cars from overseas, and in particular from South Africa. An excellent home trade during the coming season, especially for light cars, is fairly well assured. Manufacturers are making ready to meet the demand. Additional operatives are gradually being taken on, and in some cases night shifts are being worked. Large contracts are being placed for motor accessories, which have given a filip to the sheet-metal and light brass trades.

Labor Conditions

Although unemployment in the engineering industry was great during last month, the returns again show a slight improvement over the previous month. Wales is the only area that showed an increase in its unemployment returns. The demand for skilled operatives shows a notable increase. Constructional engineers are asking for more labor, particularly in the preparatory stages of manufacture. Many requests are also made for labor in the rolling stock industry, and lately there has been a call for skilled toolmakers, tool setters for multiple spindle automatics, and so on.

Shipbuilding

Local shipbuilding conditions encourage the view that the trade improvement is of a definite character. During the first eight months of this year, only twenty-one new vessels were placed on the Clyde, but since the stabilization of wages was assured three months ago, no less than forty-seven have been ordered.

JANUARY, 1923

MACHINERY

VOL. 29 NO. 5

PUBLISHED MONTHLY BY THE INDUSTRIAL PRESS, 140-148 LAFAYETTE ST., NEW YORK

ALEXANDER LUCHARS, PRESIDENT
MATTHEW J. O'NEILL, GENERAL MANAGER
ROBERT B. LUCHARS, SECRETARY

LONDON: 52 CHANCERY LANE
PARIS: 121 RUE LAFAYETTE

ERIK OBERG, EDITOR
FRANKLIN D. JONES, ASSOCIATE EDITOR

COST FINDING AND COST CUTTING

A great deal of money and effort are expended annually in the industries for finding and recording costs; but how much practical use is made of these data in actually reducing costs? The late Mr. Gantt, an acknowledged authority and expert on industrial management, told how in one of the plants he visited he found a cost-keeper and four attendants occupied in recording costs. Elaborate card-index files lined the walls of the office, and the system used for finding and recording costs was excellent. But when he asked, "How do you use these data in effecting cost reductions?" he was told that nobody ever referred to the data, or to the monthly or quarterly cost report so carefully compiled. The information was collected systematically and efficiently, but no practical use was made of it.

It is unfortunate that so much of the cost-finding activity is merely a form of accounting which brings no results whatever in cost cutting. What industry needs more than anything else are adequate methods for reducing costs, not merely for finding and recording costs. A great amount of energy is expended on cost recording, and if only part of this effort were directed toward reducing costs, the aggregate savings in the industries would run into very large figures. The report on "Waste in the Industries" prepared under Mr. Hoover's direction by the Federated American Engineering Societies clearly shows this.

Cost-finding systems have their place in every industrial establishment, but there are numerous instances in which elaborate cost systems are maintained at an expense out of all proportion to their real usefulness. More use should be made of the cost-accounting department in the practical operation of shops and factories. Superintendents and foremen should be educated to understand what the recorded figures mean, and their active cooperation enlisted in devising ways and means whereby costs can be reduced and comparisons definitely set up. Wherever this is done, a cost-accounting system becomes a means to an end rather than an end in itself. It becomes an asset, rather than a further addition to the overhead.

* * *

DETERMINING THE REAL VALUE OF MACHINE TOOLS

A new machine tool stands on the floor of the builder's shop. It represents not only a quantity of metal, plus the time necessary to produce a machine; but also mechanical ability of the highest order, years of thought and experience, scores of ideas that have been tried out—some found wanting, others found to be practicable. It is acknowledged to be superior to machines of its kind previously built. How can its value be determined?

A common method of figuring the value of the machine is to add together the labor and material cost, its proportion of overhead, and a moderate manufacturing profit. Here is a fairer method: Assuming that each operation for which the new machine is adapted had previously cost fifty cents, and that this cost is reduced by the new machine to thirty cents, we have a saving of twenty cents on every piece produced. Assuming further that the production per year of the machine it superseded was 7500 pieces, the production cost of these pieces would be reduced by $1500. The true basis of value for this machine, therefore, is its ability to save $1500 in the production cost of a year's output.

Each machine in operation represents service rendered by the builder that is worth $1500 a year to each user until superseded by another machine of greater efficiency, and the builder is entitled to payment for his skill and experience on that basis. Great fortunes have been made by users of machines that have effected similar savings; but the builder has seldom received his proportion unless protected by strong patents which are difficult to obtain. Experience, skill, perseverance and similar valuable qualities are not patentable.

We know of a manufacturer of world-wide fame who encouraged a machine tool builder to develop and perfect a machine that saves him many thousands of dollars annually, and when the machine was perfected, took over its manufacture himself. The famous manufacturer paid a moderate profit on the machines he bought, but nothing for the thought and skilled experience involved in developing them, nor for the experimental work, which cost about $30,000.

* * *

UNNECESSARY ACCURACY

Some manufacturers have but a vague idea of the accuracy really necessary in machining the parts composing the products they make, and frequently call upon the machine tool builder and the maker of small tools and other equipment, for much greater accuracy than the product requires.

A well-known manufacturer of engine lathes recently had an opportunity to quote on several machines, but the prospective customer required the builder to guarantee the accuracy of the lead-screws to within 0.0001 inch per foot. There are no lathes made for commercial use that have lead-screws of such an extreme degree of accuracy. Only specially ground lead-screws, made and measured by laboratory methods, would conform to such a requirement. Even ground taps, that are considered the last word in thread accuracy, are guaranteed to be accurate only within 0.0001 inch per inch, which is less than one-tenth the accuracy required in the lead screws referred to. Buyers of equipment should consider more carefully the accuracy that is commercially possible as well as practically required in shop practice, before specifying such extreme requirements.

In another case, a manufacturing concern rejected a large order of taps on the ground that they were not sufficiently accurate in the lead. Subsequent investigation disclosed the fact that the screws for the holes tapped by these taps, had limits of accuracy from six to ten times as great as the accuracy required in the taps.

American builders of machine tool equipment and small tools are capable of producing machinery of any degree of accuracy required for practical purposes. Were it necessary, they could produce machinery and tools of a much greater accuracy than the current commercial practice; but why increase the cost when there is no useful purpose to be served? Accuracy is a relative term; mechanically, there is no such entity as absolute accuracy. Gage-blocks are made to be accurate within 0.00001 or even 0.000005 of an inch, but no one would think of requiring such accuracy in ordinary commercial work. Unnecessary accuracy is expensive and wasteful.

The Machine Tool Salesman

By a Machine Tool Sales Manager

THE rapid increase in the number of specialized machine tools imposes a greater responsibility and calls for greater knowledge on the part of the machine tool salesman. Not so many years ago the salesman was required to know only standard machine tools, and the thoroughness of his knowledge of standard tools was often worthy of admiration. He knew the merits, and even the dimensions, of the machines he sold; he also knew his competitors' machines, and could make comparisons in a very effective manner; he was thoroughly equipped to sell along the lines in which selling was conducted at that time.

Then came a new period in machine shop practice. Out of the standard tools grew many new types of specialized tools, with a narrower field of application but an increased usefulness, because of increased productivity. The machine tool salesman could no longer talk about these tools by comparing the diameters of the front spindle bearings; he had to talk production methods, and tool and fixture equipment. With this change in the character of the tools came also a change in the buying methods of the industries using machine tools. Instead of waiting for buyers to come and seek this class of machinery, the makers had to go out on an educational campaign and instruct the buyers as to the field of application of the new machines.

The Fields for Standard and Special Machines

There always will be a field for standard machine tools. In fact, many machines that were originally regarded as specialized, have become so general in application that they are now considered standard. The multiple-spindle drilling machine and the centerless grinder are good examples. Some machine tool men believe that specialized tools do not encroach upon the field of standard tools, but merely increase the scope and size of the machine-using industries. This opinion is based on the frequently observed fact that whenever a machine tool user has developed his plant to a point where he requires specialized tools, he also becomes the consumer of the products of a number of smaller concerns who serve the larger plant. Perhaps the best known example of this is the number of tool shops that owe their existence to the demand for jigs and fixtures to be used with high production and specialized machine tools.

From the selling standpoint, it is evident that new types of specialized machines add to the burden of the machine tool salesman. He has the new tools to sell in addition to the standard tools. The new machines require more sales effort and more investigation of shop methods and production systems than standard tools. The machine tool salesman, to a large extent, must create his own market for specialized tools. To be thoroughly successful, he must have the same knowledge of standard tools as the machine tool salesman of the past; in addition, he must have an equally thorough knowledge of new types of specialized machines. To gain this knowledge without close application and study, is impossible—a continuous study to keep posted on the progress taking place is necessary.

The Successful Salesman Must Be a Hard-working Student

The knowledge of the contents of his catalogue was a valuable part of the equipment of the machine tool salesman of the past. Today, one meets many salesmen who have never read thoroughly the catalogues of the tools they sell. They have merely looked through them, with emphasis on the "through." Many salesmen have never really studied the catalogues of the machines they sell or worked out the selling points to such a degree that they are able to make effective use of them.

Standard tools form the basis of specialized tools, and without a thorough knowledge of standard machines and their operation, there is no basis on which to build a selling knowledge of specialized tools. Now, how can a salesman obtain this fund of knowledge without which he will never be really successful? Failure to study the catalogues of his firm is not the only error of omission on his part. There is a great deal of valuable information in the trade journals that would be useful to him. How many salesmen make it a part of their routine duty, for example, to read MACHINERY? Do they read it with a view to permitting nothing of value to escape them, or do they occasionally see a copy, look through the New Machinery and Tools Section and skim through the advertisements here and there?

The articles describing the processes and equipment used in manufacturing plants are among the best sources of information for the machine tool salesman. There is no part of the magazine that he can afford to miss. It is not the intention of this article to censure the salesman, but rather to point out to him the position of great responsibility that he occupies as regards both his customers and the concern he represents. The points emphasized in this article are mentioned because it is believed that the salesman is not always fully aware of his responsibility and his opportunities. A systematic method of study would result in a threefold benefit—to his customer, his firm, and himself—by increasing efficiency and production, augmenting sales, and adding to his own income, as well as strengthening his reputation as a salesman and his standing in the industry.

How the Salesman can Save Overhead Costs

Every manufacturer can cite examples showing how time and effort could have been saved by an alert salesman. One item of overhead cost that reaches a large total is the cost of sales correspondence. Most sales managers know that it is an everyday occurrence to receive letters from the sales force requesting information that is given in the catalogue, and that has been in the catalogue for years. The cost of answering a letter on a technical subject has been estimated at about $1.50. The most expensive part of the matter, however, is the loss of time that could be better spent.

Those concerns who make specialized production machinery find that the greatest delay and expense is incurred in securing full and complete information to enable a production estimate to be submitted. The information required relates to quantity produced, method in use and reason for using this method, feeds, speeds, present production time, kind of material used, previous and subsequent operations, and all other factors that have a bearing on the work to be produced. The machine tool builder looks to the salesman to obtain this information. Many letters are often necessary before the complete information has been obtained, and many hours of engineering time are wasted because some information that should have been included is missing, or because some of the data submitted are incorrect. Accuracy in submitting information to the home office is one of the most important things in the salesman's report, but unfortunately, accuracy in detail is not one of the most common characteristics in otherwise successful salesmen.

Unnecessary Calls by a Factory Representative

Another source of unnecessary sales expense that could be saved by a competent salesman is the premature or

useless traveling of special men from the shop to assist the salesman. The reason for sending a man from the factory is to help the salesman in a situation that requires the experience of an engineer. Many manufacturers find that a salesman will call for assistance from the plant in supplying information to the customer that he already has or easily could obtain. Quite often the salesman makes no attempt to obtain the information for himself, and merely makes an appointment for the factory man.

There is frequently a lack of mutual appreciation on the part of the factory engineer and the machine tool salesman. When the engineer studies a piece of work to determine the best way of producing it on his machine, his efforts usually result in a device or an idea that—it appears to him—should have an irresistible effect upon the prospective customer. If the prospective buyer is not convinced to the extent of placing an order, the engineer is prone to believe that the salesman is at fault because he himself has failed to understand the engineering advantages, or to stress their value to the customer. The engineer believes that if he had only been present his ideas would have been accepted.

The salesman, in turn, is prone to regard the engineer as a source of unlimited mechanical ideas, and frequently asks him to work out more and more ideas that constitute merely a useless overhead expense. The salesman's objective is an order, and he is willing to abandon any feature that fails to impress his prospect and to call for some different engineering ammunition. The engineer, again, frequently fails to explain his plans so that the salesman is able to transmit them to the customer. Often a few lines in a letter are supposed to convey an idea that exists mainly in the engineer's head. How can the salesman be expected to carry on his sales work if he receives only a few lines in a letter, but not the ideas?

Both the engineer and the salesman are necessary in their respective fields, and their work should be dovetailed. They should cooperate and each should be willing to do his utmost to provide the other with all the information that he needs in order to do his work properly.

For the education and instruction of their salesmen, some machinery firms conduct salesmen's meetings where the tools to be sold are studied and the selling points discussed. Other firms assign to each salesman a particular class of tools, and at periodical meetings the men review each other's territory and suggest tools and methods of meeting the production problems of prospective customers. Both are good systems, because back of them is the idea of furthering the education of the salesman.

The machine tool salesman is earnest and sincere. He realizes that his success, the customer's success, and the firm's success are all interdependent, and that if he regards all problems from his customer's viewpoint, he will be able best to further his own and his firm's interests. But like so many other men in all walks of life, he sometimes forgets that he must continually go to school. It is to emphasize this point that this article has been written. The salesman who succeeds is the one who keeps everlastingly at it.

MACHINE TOOL STATISTICS FOR 1921

The accompanying table gives a summary of the machine tool statistics for 1921 as compiled by the Bureau of Census at Washington. Comparative figures for 1919 are also given. The table shows that the value of the machine tools built in 1921 was not quite one-third the value of the machines built in 1919. More detailed statistics will be published later in regard to a number of factors affecting the industry, but the present table gives, in a comprehensive manner, the main facts relating to the number of machines built and their value. In several instances, it will be seen that the number of machines built did not decrease in the same ratio as the value, due to the price reductions made in 1921.

COMPARATIVE STATISTICS OF MACHINE TOOLS IN 1919 AND 1921
(Compiled by the Bureau of Census, Washington, D. C.)

	1921		1919		Per cent of Decrease (Value)
	Number	Value	Number	Value	
Boring machines:					
Horizontal	632	1,340,106	826	4,437,937	69.8
Vertical	266	1,840,792	607	4,329,654	57.5
Drilling machines:					
Multiple-spindle	676	1,106,097	1,440	1,998,594	44.7
Radial	2,243	1,548,058	2,732	5,702,134	72.9
Sensitive	1,154	226,801	5,993	1,974,917	88.5
Upright	1,493	593,956	6,477	1,754,463	66.1
Grinding machines:					
Cylindrical.					
Plain	2,022	1,841,701	8,359	12,011,923	84.7
Universal	1,105	480,584	1,792	2,066,166	76.7
All other	17,919	1,147,460	2,735	1,725,252	33.5
Lathes:					
Engine	5,117	5,229,884	17,188	23,239,849	77.5
Turret	1,087	1,580,842	4,657	10,140,582	84.4
Bench and all other	1,063	1,872,928	7,186	4,094,346	54.3
Milling machines:					
Hand feed	468	233,945	.....	*	.....
Power feed					
Plain	536	812,346	4,635	6,171,040	86.8
Universal	494	1,092,234	3,163	5,580,044	80.4
Vertical	212	415,275	1,304	2,755,943	84.9
All other	463	1,269,458	2,378	4,019,338	68.4
Presses:					
Punching	20,045	7,284,166	32,168	5,400,044	34.9†
All other	3,783	1,643,244	3,618	956,855	71.7†
Bending machines	54	164,315	153	941,739	82.6
Broaching machines	530	616,933	549	1,395,300	55.8
Gear-cutting machines	840	1,736,667	2,688	5,845,565	70.3
Hammers, pneumatic and other	3,550	1,113,704	38,535	4,951,974	77.5
Planers	176	1,271,824	1,482	8,128,655	84.4
Pipe machines	1,192	570,509	4,118	2,481,441	77.0
Portable tools	.....	4,411,409	.....	10,907,928	59.6
Screw machines	2,661	2,839,667	6,227	9,625,046	70.5
Shapers	1,418	1,020,342	4,515	4,230,695	75.9
Shears	3,347	906,722	1,367	1,566,467	42.1
All other machine tools	.....	5,362,711	.....	31,313,335	82.9
Parts and attachments	.....	8,936,547	.....	‡	.....
All other products	.....	7,257,934	.....	32,652,932	77.8
Total value		67,769,161		$212,400,158	68.1

*Not reported separately in 1919. †Denotes increase. ‡Included in "all other products" in 1919.

* * *

The investigations on molybdenum as an alloying element in steel, conducted at the Ithaca, N. Y., field office of the United States Bureau of Mines, in cooperation with the Vanadium Corporation of America, will be continued. The object of this work is to add to the technical information on the value of molybdenum, one of the few elements entering into alloy steels of which the United States possesses an abundance of high-grade ore, readily mined and handled. Though there are limitations to its use, it is plainly of great value in steel that is to be heat-treated to produce superior qualities. Molybdenum is slowly taking rank along with nickel, chromium, and vanadium as an alloying element for high-grade steel.

Rolling Threads in Screw Shells

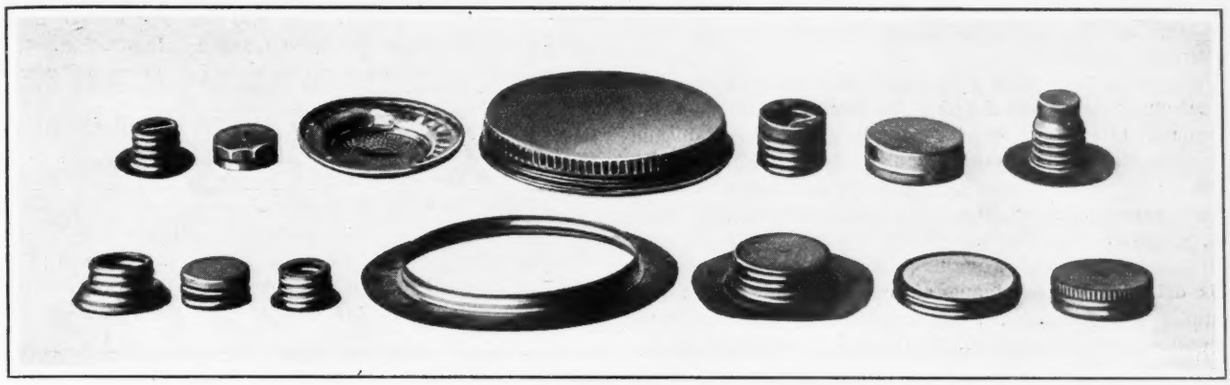


Fig. 1. Examples of Caps and Shells with Rolled Threads, Beads, Curled Edges and Knurled Parts

THE final operations in the manufacture of jar caps, salve and pill boxes, electric lamp light sockets, bottle caps and similar articles include threading, knurling, beading, curling, and trimming; these operations are performed by rolling. For handling work of this kind, a special automatic machine, illustrated herewith, is manufactured by the V & O Press Co., Glendale, L. I. Some idea of the nature of the work for which these machines are used may be obtained from Fig. 1. The operation of the machine is simple, as indicated by the two set-ups shown. The operations (exclusive of trimming) are accomplished by two rolls, over one of which the previously drawn shell is passed and held while the other is advanced to bear firmly against the work. A third roll is required for trimming.

The machine is provided with an automatic feed in the form of a chute or magazine which has a top guide bar that is adjustable for various diameters of work and an adjustable bottom for various lengths. A slight change in the bottom member of the chute adapts it for flanged work, such as is shown in the middle of the bottom row, Fig. 1.

The machine shown in Fig. 2 is set up for handling caps with a curled edge for Mason jars. The flanges that are required on such work to form the curled edge overlap when placed in a chute of this kind, some flanges being on one side and some on the other of the preceding cap. A common trouble arising from this condition is due to the interference of the flanges, which prevents the work from being passed directly to the chucking roll. This is taken care of in this machine by an oscillating movement imparted to the lower end of the chute, which is produced by a cam beneath the machine and a connecting arm *A*. The arm carries two cam rolls, one of which rides on the periphery of the cam, producing the oscillation, while the other bears on the side of the cam. A latch *C* holds the lowermost cap in position in the chute; this latch is depressed at the upward movement of the chute and permits the work to be brought in position for rolling. The chucking or lower roll *B* may be designed to meet the requirements of varying classes of work.

The operations performed on the Mason jar cap are threading, coarse knurling, and curling the edge, all of which is done in one pass of the work through the machine. The threads and knurled part of the chucking roll are somewhat smaller in diameter than the work, to permit the caps to be readily stripped. The curled edge is produced by a groove in the chucking roll and a corresponding flange on the upper roll *D*. The rolls are brought together by cam action

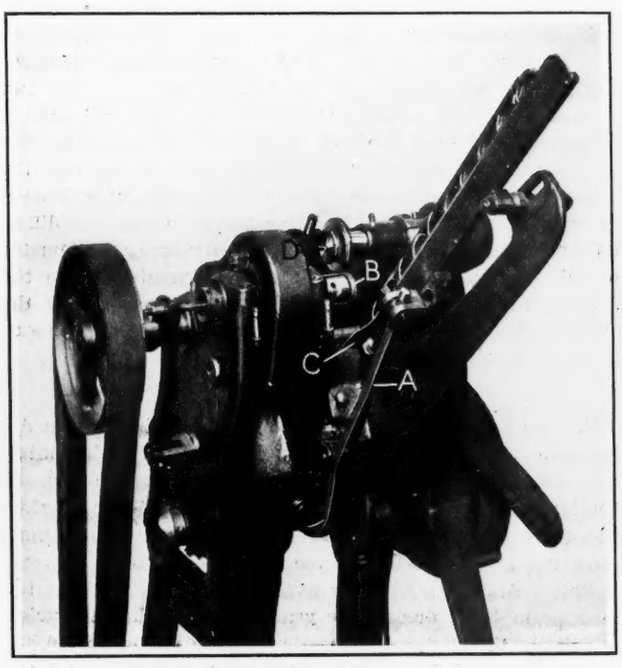


Fig. 2. Automatic Thread Rolling Machine set up for handling Mason Jar Caps

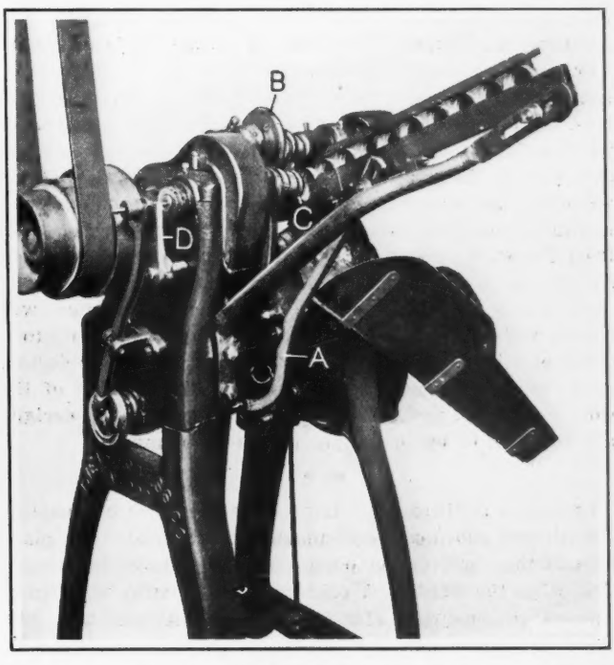


Fig. 3. Automatic Beading and Trimming Machine set up for handling Pill Boxes

through the medium of a toggle-lever connection at the rear of the machine. The cam is adjustable, making it possible to vary the number of revolutions during which the rolls maintain pressure on the work. The upper roll is carried on an auxiliary shaft that has bearings in a rocker arm, the latter being connected to a toggle mechanism. This roll has a flange of large diameter which acts as a stop for the work on the chucking roll and prevents it from being incorrectly located.

As soon as the rolling operation has been completed, the rocker arm recedes and the ejecting mechanism or knock-out is brought into operation. The knock-out consists simply of a rod passing through the spindle of the machine which strikes against the inside of the work and is actuated by a side cam and lever on the side of the machine. The shaft that carries all the cams is driven from the main driving shaft by gearing located at the opposite end of the machine. This drive is connected and disconnected by a pin clutch operated by a foot-treadle. The jar caps are made of 0.010-inch sheet tin, and are knurled, threaded, and curled at the rate of sixty per minute.

Combination Beading and Trimming

These machines can be adapted for various shapes of work and provided with special auxiliary tools for handling the more special work. Much difficulty has been experienced in the past in attempting to bead and trim work of this kind in one operation, but Fig. 3 illustrates how the machine may be successfully employed for accomplishing this result.

Parts having a bead, like a pill box, are representative of the work handled with the set-up shown. Suitable rolls for producing the bead are used, and they are operated similarly to those previously described. The magazine feed or chute is also of the same design and in this illustration is shown in the position occupied just prior to depositing the work on the chuck. An auxiliary rocker arm is incorporated in the design of this machine; the rocker arm carries the trimming roll *B* which is brought into operation after the pill box has been beaded. Rolling the bead takes up some of the stock from the edge of the shell and is likely to leave it somewhat irregular, necessitating a trimming operation; consequently, the rolling must be performed first.

The scrap produced by trimming the work must be removed from the nose of the spindle; for this purpose a stripping device operating in conjunction with the regular knock-out is used. A sliding collar *C* fits over the spindle and is operated by a yoke connected to the shaft on which finger *D* is attached. When the knock-out advances, the stripping mechanism is also advanced, and it is afterward returned to its normal position by means of a spring on the short stripper shaft. The scrap and the trimmed and beaded work are deposited in a sheet-iron chute or trough which delivers the work to a receptacle at the extreme end and permits the scrap to fall through an opening left at the vee where the sides of the chute nearly meet, thus eliminating the troublesome operation of later separating the scrap from the work. These pill boxes are made from 0.010-inch sheet tin at a rate of fifty-five per minute.

Automatic machines of the type here illustrated will handle work from ½ inch to 4 inches in diameter, up to a depth of 3 inches. By the use of rolls of the proper design, irregular shaped shells may be rolled. The design of the work affects the production rate, but on the simpler designs a production of up to 100 per minute is obtainable.

* * *

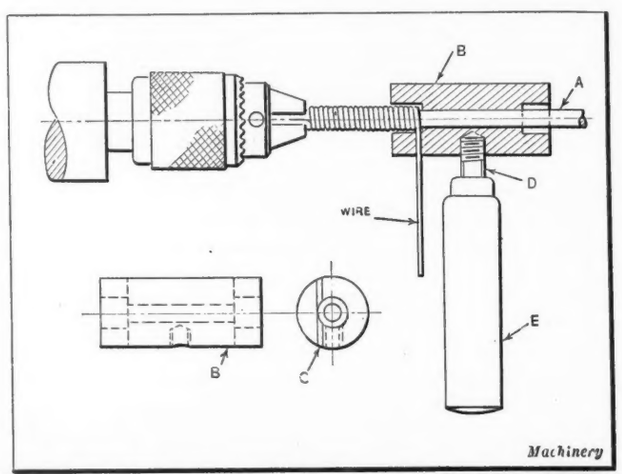
Extensive additions and improvements are to be made at the Altoona shops of the Pennsylvania Railroad. The plans include the construction of two large buildings in connection with the Juniata Works. One shop will be entirely devoted to repairing and building locomotives, and will cover an area of 340 by 670 feet; in addition, a reinforced concrete storehouse will be erected, three stories high, with basement, 60 by 400 feet.

TOOL FOR WINDING RESISTANCE COILS

By C. E. STEVENS

Resistance coils of various diameters and lengths were required in the manufacture of electric toasters and similar appliances. In order to determine the best method of producing these coils, several different coil-winding tools were tried out by one manufacturer, and the type of tool finally adopted is shown in the accompanying illustration. This tool not only produced accurate coils but increased production as well.

The arbor *A* is placed in the chuck of a small speed lathe, the length or distance that it projects from the end of the chuck being the same as the length of coil to be wound. The winding bushing *B* is of tool steel or drill rod, and is hardened. The small hole extending through the bushing is made a slip fit for the arbor *A*, and the two ends of the hole are counterbored to a diameter equal to the diameter of the arbor plus twice the diameter of the resistance wire



Method of winding Resistance Coils

from which the coil is to be wound. A slot *C* is cut in the end of part *B* as shown. This slot is 0.002 to 0.005 inch wider than the diameter of the wire and extends to the bottom of the counterbore. Both ends of part *B* are slotted, the slots being located opposite each other so that the block can be used to wind springs having either left- or right-hand spirals by running the spindle in the required direction. A small stud *D* is screwed in the center of the bushing to hold the wooden handle *E*.

In winding the coil, the end of the wire is placed between the jaws of the chuck, and the lathe spindle is given two or three turns by hand to start the coil. The tool body *B* is then placed over the coil so the wire rests in the slot as shown. The lathe is then started, and by pressing the tool toward the chuck, the coil is wound close and will snap or break off when the end of the arbor is reached. A different bushing or tool and arbor is necessary for each diameter of coil. If the tool *B* is made a good running fit on the arbor, and is properly counterbored at the end to fit the outside diameter of the coil, the lathe spindle can be run at any desired speed.

* * *

The work of the British Engineering Standardization Association, as reviewed at the annual meeting of the organization, is steadily progressing. Seventy-two standard specifications, new or revised, were issued during the past year, and there are now nearly 2000 engineers who give of their time and experience to the standardization work in Great Britain. About $75,000 was expended on this work by the association itself during the year, of which the industries in spite of the business depression, contributed over $40,000, the remainder being appropriated by the British and the Dominion Governments.

American Machine Tools in France

By a French Machine Tool Dealer

THE outstanding factor in the machine tool situation in France is the interest in American tools which has been noticed during the last six months, although orders were not forthcoming to any great extent, owing to the high prices. Special interest was shown in small tools, such as drills, reamers, and cutters made from carbon steel. The quality of the steel is the main reason for the demand for American tools of this type. Chucks and other accessories have also been in demand. American small tools made from high-speed steel, on the other hand, find no sale, because they are too high-priced for the French market, with the exception of entirely special tools. The sale of American machine tools and small tools during the last few months was somewhat aided, temporarily, by the exchange situation, there being a period when the value of the franc rose appreciably, although it soon fell again. Importers of American machine tools also made great sacrifices in order to meet the prices of French tools. In a few cases the American manufacturers cooperated generously with the French dealer and shared in the sacrifice.

Effect of the Wiesbaden Agreement

Under the Wiesbaden agreement, materials and equipment are obtained from Germany for the rehabilitation of the devastated regions. Manufacturers in the devastated area, whose plants were demolished, obtain from the French Government, upon application to the official Mandataires, who acts as an intermediary between German manufacturers and French buyers, a kind of scrip, which is good only for the buying of German products. This practically removes the manufacturer in the devastated region from the market, as far as American or domestic French machinery and equipment are concerned. Furthermore, the German machines are imported into France at the minimum rate of duty, and are therefore obtained by the French customer at a very cheap price, eliminating practically all competition. Even in cases where American machine tools might be preferred, the French buyer cannot afford to sacrifice the advantage of buying the German machines under the Wiesbaden agreement at a very low price.

General Conditions in the Machine Tool Market

The competition offered by French and German manufacturers is very severe, and the few firms in France that are still exclusively handling American machinery and tools find it difficult effectively to meet this competition on account of the differences in price between American and European machines. If the price of American machine tools is assumed as 100 per cent, French machines, many of which are now of very good quality, sell at 60 per cent, and German machines as low as 40 per cent. German competition is especially severe in molding machines, and there is a strong possibility of such machines being built in France, unless American manufacturers in this line constantly develop new designs, so that they are always in the lead.

The stock of second-hand machinery, especially of the less high-grade types, is still great, but is gradually being absorbed, mostly by machine shops of the secondary class, garages, and repair shops; not infrequently also the larger shops have been forced by economic conditions to purchase machines of this class against their own best judgment. The automobile business is recovering, and this has created a fair demand; but this is offset to some extent by the fact that some of these shops have disposed of surplus machines. The demand for automatic machinery and high-production machines in general is increasing.

If the exchange rate should settle down to ten francs to the dollar, American machine tools could be sold in France to some extent, as there exists a definite demand for high-class American tools and only the price stands in the way of sales. The classes of machines mainly required are automatic screw machines, universal milling machines, universal grinding machines, gear-cutting machinery, high-production bolt and nut machinery, small tools made from a high-grade carbon steel, and precision tools. On the other hand, the domestic and German competition in lathes, shapers, all classes of drilling machines, lathe and drill chucks, and hoisting equipment, makes it very difficult to sell machines and equipment of these classes in France.

The Manufacture of American Tools in Europe

A few American manufacturers have started to manufacture machine shop equipment in France. In some cases some of the parts are made in America and shipped to France, part of the work and the assembling being done there. In other cases, the entire manufacture is carried out in France. This applies to electric shop trucks, grinding wheels, and die-heads, and is likely to extend to drill chucks. In the metal-working field outside of the shop equipment field, there has been even more activity along these lines, as in tube manufacture, agricultural machinery and tools, and structural steel sections.

The article published in September, 1922, MACHINERY, by A. L. Valentine on the manufacture of American machines and tools in France, contains correct conclusions. In many lines of tools, the American manufacturer cannot successfully compete unless he has a French license operating a factory that at least partially manufactures and assembles his product in France. The main reasons are that the duty on imported machinery and tools is very high and likely to be higher if the foreign competition with the new French industries becomes too severe; the labor obtainable in France is much cheaper than American labor, because the cost of living there is not as high as in America; and the unfavorable influence of the exchange rate could be largely overcome by manufacturing in France.

The many costs that would be avoided are obvious. Raw materials of good quality are obtainable in France. Quicker deliveries could be quoted, and the representatives in France would not be required to carry such large stocks as is now necessary. In the small tool field, particularly, this becomes a very important item, because, unless small tools are carried in stock by the French dealer, there is no possibility of sales. It would take too long to order from the United States.

Cooperation with Dealers in France

The dealers already familiar with the European market could take the selling problem entirely off the hands of the French licensee, who, operating along the same lines and with the same equipment as the American manufacturer, could devote his entire energy to the manufacturing problems. A good organization could be built up in France entirely by native French engineers and workmen, who will be found to carry out any laid down program in a manner that would meet all requirements.

Meanwhile, American manufacturers who wish to maintain their sales and keep their name before the French buyer can greatly aid the dealers in American machine tools by

sending them machinery and tools on consignment, to which a fixed rate of exchange should apply at any time. Present conditions do not permit the dealers to add any appreciable amount to their already large stocks, unless the American manufacturer cooperates with them in this manner.

Were this generally done, it would be possible for the French dealer to continue his sales work and to bring before the French buyers of machine tools and equipment the new developments that are continually being made in America. Firms that have constantly represented none but American machine tool builders would then be encouraged in the continuation of this policy, and would be ready to further the sales of American tools as soon as changed conditions bring about an increased demand.

* * *

MECHANICAL ENGINEERS' ANNUAL MEETING

At the annual meeting of the American Society of Mechanical Engineers, which was held in the Engineering Societies' Building, 29 W. 39th St., New York City, December 4 to 7, special sessions were devoted to management, materials handling, machine shop practice, education and training for the industries, research, steam tables, fuels, railroads, general machine design, power engineering, safety engineering, standardization, ordnance, aeronautics, and forest products. In addition, there was an evening session on engineering and economics at which addresses were made by Wesley C. Mitchell, director of research, National Bureau of Economic Research, on "Making Goods and Making Money"; and by E. M. Herr, president, Westinghouse Electric & Mfg. Co., on "The Human Problem in Industry." A valuable contribution to the discussion on Mr. Mitchell's paper was made by Ernest F. DuBrul, general manager, National Machine Tool Builders' Association. Copies of these and other papers and discussions presented before the meeting may be obtained by addressing the American Society of Mechanical Engineers, at its headquarters given above.

The President's Address

The president of the society for the past year, Dexter S. Kimball, Dean of the College of Engineering of Cornell University, chose as the subject for his address "National Leadership." He pointed out that the ultimate criterion by which any civilization will be judged will not be its armies or navies, its great edifices, nor its wealth, but the degree of well-being—physical, mental, and spiritual—that it bestows upon its people. He stated that our civilization differs from those that have gone before mainly in our power to produce the necessities of life—to feed, clothe, and house the multitude. This power has come through the use of what we call the "scientific method," by which we aim finally to replace the words "I think" with the words "I know" in all our activities. The success of this method in conquering nature and turning its resources to useful purposes has been most remarkable, and it has become increasingly clear that physical, mental, and spiritual well-being depend primarily upon the industrial background, and that the benefits of modern industrial methods must be more widely distributed.

"If I read the ideals of American democracy aright," said Dean Kimball "we are committed in this country to an endeavor to secure universal well-being. The benefits that have accrued to all classes of people are beyond question, and they are the more apparent when comparison is made either with older forms of civilization or even with other nations. The general level of comfort and education is unquestionably higher than has ever been attained." Yet the advantages due to this industrial development have brought with them many problems that are not yet solved.

No one would presume to say that the engineer alone can solve the industrial riddle, but it is clear that he can make a very great contribution to the solution.

Helical Gearing for Planers

At the machine shop session Forrest E. Cardullo of the G. A. Gray Co., Cincinnati, Ohio, read a paper on "A New System of Helical Involute Gearing for Use on Metal Planers," in which he gave particulars of a system of helical gearing designed by him for use on planers, in which the directions of rotation and the helical angles of the several gears are so chosen as to counterbalance and minimize end thrust, advantage being taken at the same time of the end thrust to counterbalance the side thrust of the cutting tools. The tooth form adopted is an involute having a 14½-degree pressure angle, a pinion addendum of $3/2p$ inches, and a pinion dedendum of $1/2p$ inches, p being the normal diametral pitch. The advantages of this form of tooth for the work in question were enumerated and dimensions of a pinion, gear, and rack designed according to the principles set forth in the paper were given in tabular form.

Spherical Gears

A paper entitled "Spherical Gears" was read by Charles H. Logue, consulting engineer, Syracuse, N. Y., in which it was stated that the basis for a study of all gears whose pitch surfaces are in rolling contact is found in the study of the bevel gear. By acquiring this point of view, not only are the elementary features of bevel gear design brought out and applied to spur gears, but also the real connection between the two types is shown. This is essential to a complete understanding of either.

Testing Involute Spur Gears

A paper on the subject of testing spur gears was read by M. Estabrook, of the Niles-Bement-Pond Co., New York. In this paper some of the more commonly used methods of testing or inspecting spur gears were briefly reviewed, and two new devices for testing gears were described; namely, the Saurer gear-testing machine, a Swiss development by means of which the accuracy of the tooth curves, spacing, and eccentricities can be determined with a high degree of precision; and the odontometer, an American instrument for quickly and accurately testing gears for tooth curves and spacing, and which can be used during the processes of manufacture, making it possible to locate troubles in the machines or tools.

Hydraulic Variable-speed Drive for Machine Tools

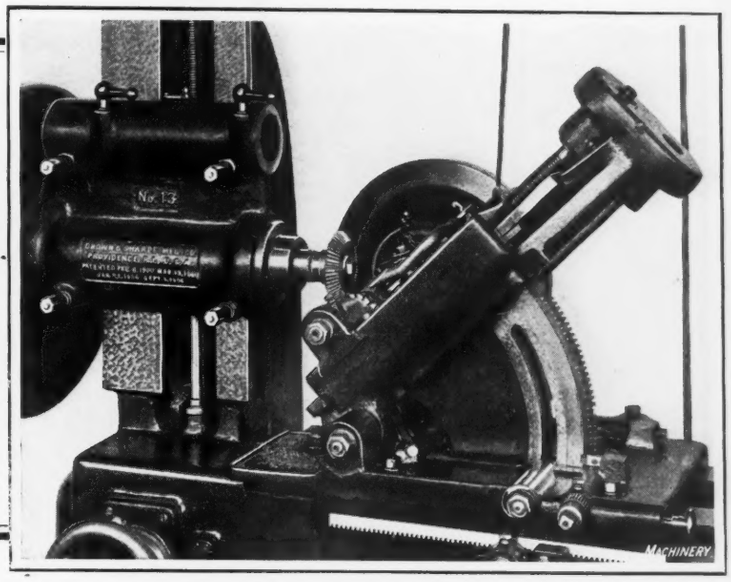
A paper entitled "Applications of Hydraulic Transmission Variable-speed Drive to Machine Tools and Manufacturing Processes" was read by Walter Ferris of the Oilgear Co., Milwaukee, Wis. Hydraulic transmission has been in course of development as a variable-speed drive for twenty-five years, and has often been applied to gun control, turret control, and steering gears on naval vessels during the last fifteen years. Its accuracy and flexibility of speed control, mechanical efficiency, durability of mechanism, and ability to stand abusive accelerating and stalling loads without overheating, are well established, yet this type of drive has never attained extensive introduction in the industries, where its most extensive field seems to lie. The author described and illustrated a number of applications of the "Oilgear" to machine tool driving, broaching, and hydraulic presses.

Power Required for Cutting Metals

An investigation into the power required for cutting metals, by Fred A. Parsons, of the Kempsmith Milling Machine Co., Milwaukee, Wis., gave results of an investigation extending over a period of more than ten years, the purpose of which has been to determine the fundamental laws governing milling, turning, planing and drilling operations on the various metals and alloys used in machine construction. The author's results were presented in the shape of formulas and tables by means of which the power required to machine metal in any given case may be calculated.

Cutting Bevel Gears with Formed Cutters

By FRANKLIN D. JONES



SOME automatic gear-cutting machines of the formed-cutter type are designed for cutting either spur or bevel gearing. Such machines are so arranged that the cutter-slide can be set parallel to the work-spindle for spur gears, and at an angle for bevel gears. While bevel gears are often cut by means of formed milling cutters, this method is not very accurate, because it is impossible to do more than approximate the converging form of tooth when a cutter that merely reproduces its shape is used. In fact, when bevel gearing is cut by this method, it is usually necessary to correct the teeth by filing.

Although these milled gears are sufficiently accurate for many purposes, especially when the speeds are relatively low, they are unsatisfactory for high speeds and where accurate tooth curves are of importance. For cutting small and medium-sized gears of the better grades, the general practice is to use a generating type of machine, whereas for very large bevel gears, the templet or form-copying type is in common use.

Determining Formed Cutter to Use for Bevel Gears

A Brown & Sharpe automatic gear-cutting machine adapted for cutting either spur or bevel gears is shown in the heading illustration set up for cutting a bevel gear. The formed cutters used for bevel gears are similar to spur gear cutters, except that the thickness is less. A thinner cutter is necessary, because it must pass through the narrow space between the inner ends of the teeth. Standard Brown & Sharpe cutters are of such thickness that they will cut face widths up to one-third the length of the pitch cone. These cutters are made in series of eight for each pitch, the different numbers being selected with reference to the number of teeth in the gear and the pitch cone angle. If the number of teeth in a gear is divided by the cosine of the pitch cone angle, the result represents the number that determines the selection of the cutter. After the gear blank and cutter have been mounted on the machine, the cutter is set in a central position by means of a special gage used for this purpose. Gears that are cut with a cutter off center will run more quietly in one direction than in the other.

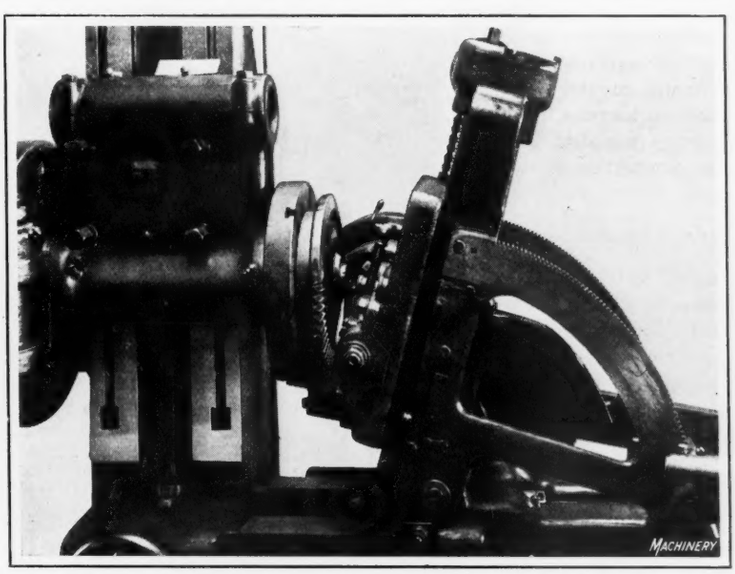


Fig. 1. Cutting Bevel Gears of the Ring Type

Setting Cutter-slide at Required Angle

When bevel gears are cut on machines of the generating type, the cutting angle is determined by subtracting the dedendum angle from the pitch cone angle. When a formed cutter is used, however, better results are obtained by subtracting the addendum angle from the pitch cone angle. When this cutting angle is used, the bottom of the tooth space does not incline toward the apex of the pitch cone, but is parallel to the face of the mating gear. The object of modifying the cutting angle slightly when a formed cutter is used, is to obtain a tooth shape which more nearly approaches the correct form. The cutter-slide (see the heading illustration) is set to conform to the cutting angle by means of graduations on the side of the segment.

Adjustment of Cutter

The total depth of the tooth space for a bevel gear is measured at the large end of the tooth, and at right angles to the pitch line, that is, along the back edge. A simple method of adjusting the cutter for depth is as follows: A gage is first used to scribe a line along the back edge, representing the bottom of the tooth space. This gage may be a small fixed type or an adjustable design with micrometer graduations. The cutter carriage is moved along the bed, and the work-spindle slide adjusted downward until the cutter has been fed into the blank to the depth indicated by the line.

The cutter used for bevel gears cannot be thicker than the spaces between the small ends of the teeth. Hence, if the teeth were finished with a cutter set in a central position relative to the blank, the spaces would be too narrow at the large ends and the teeth too wide or thick.

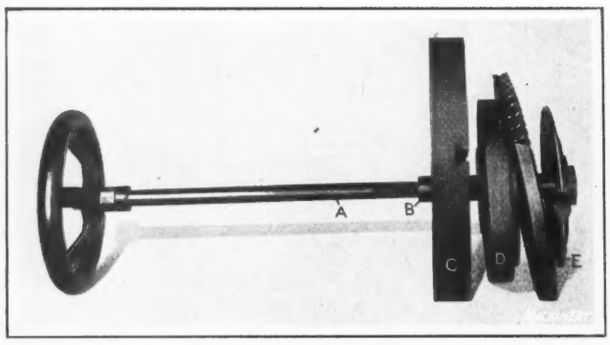


Fig. 2. Equipment for holding Ring Gears

To prevent this, it is necessary, in cutting bevel gears, to set the cutter slightly off center, first in one direction, for finishing the teeth on one side, and then in the opposite direction for milling the teeth on the other side. Before the cutter is offset for this purpose, however, the tooth spaces may be roughed out with the cutter in the central position. According to one rule, this should be done when cutting cast-iron gears coarser than 5 diametral pitch, and the central cuts are usually considered an advantage for nearly all steel bevel gears. As the method of determining the amount of offset has been described previously in MACHINERY, and is also explained in MACHINERY'S ENCYCLOPEDIA, (Vol. III, page 327), it will not be included in this article.

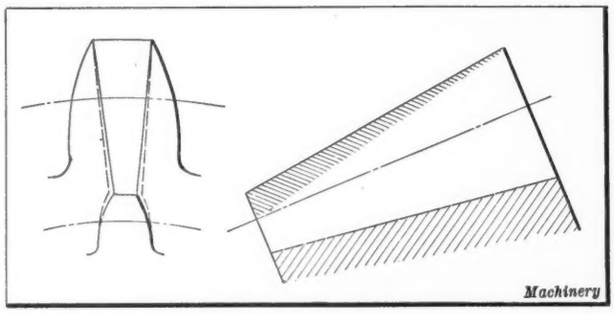


Fig. 3. Diagram showing Part of the Gear Tooth that is corrected by filing

Since the shape of a formed cutter for bevel gears can be correct only for one section of the tooth, the cutter outline is based on the tooth shape at the large end; consequently the small end of the tooth is too thick above the pitch line and it does not have enough curvature, as indicated by the dotted lines in the end view of a tooth in Fig. 3. If the cutter outline conformed to the shape of the teeth at the small ends, too much metal would be removed from the large ends above the pitch line. Therefore the cutter is shaped to suit the large end, because then it is possible to correct the teeth by removing the surplus metal at the small end.

This error in thickness above the pitch line, which progressively increases from the large to the small end, is corrected ordinarily by filing the teeth. The triangular area indicated by the fine shade lines shows what part of the tooth surface should be corrected by filing. No metal should be removed at or below the pitch line, because if the gear has been milled properly the pitch line thicknesses at both large and small ends will be correct.

Method of Holding Bevel Gears of the Ring Type

A Brown & Sharpe automatic spur and bevel gear-cutting machine is shown in Fig. 1 roughing out the teeth of bevel gears for automobiles. These gears are of the ring form, and are held by a special device, the arrangement of which is shown more clearly by the detailed view, Fig. 2. The draw-in bolt *A* passes through the spindle of the machine, and the threaded end engages the long sleeve *B*, which passes through face-plate *C*, work-holding plate *D*, and clamping plate *E*. The gear fits over a shoulder on plate *D*, against which it is firmly held by plate *E* when the handwheel on the draw-in bolt is used to bind the parts together. These ring gears have fifty-five teeth of 4 diametral pitch, are made of 3½ per cent nickel steel, and are cut at the rate of thirty-three gears in nine hours. The cutter speed employed for cutting these bevel gears is 130 revolutions per minute.

Milling Bevel Gear Segments

The automatic gear milling machine shown at work in Fig. 4 is a cam-controlled type adapted for cutting spur or bevel gearing as well as for various other special operations. This machine is made by the Bilton Machine Tool Co., Bridgeport, Conn. The particular operation illustrated is that of cutting spark and throttle control segments. The cutter is mounted on a horizontal spindle carried by a vertical slide attached to the end of another slide or ram which is free to move horizontally and is actuated by a cam at the rear. At the top of the vertical slide there is a form or templet which is held in contact with a finger at the front end of a pivoted lever arm. This contact between the form and finger is maintained by compression springs located in the head of the ram beneath the vertical slide cap. The lever arm carrying the finger is operated by another cam at the rear, and it controls the vertical position of the cutter-slide.

When the machine is at work, the lever arm moves the cutter down to the working position; then the horizontal ram is given a forward feeding movement by a "stroke cam" of the right throw. When this occurs, the path followed by the cutter depends on the shape of the form at the top of the vertical slide; for instance, if a straight horizontal surface is in contact with the finger on the lever arm, the cutter will move parallel to the axis of the work-arbor, as when cutting spur gears. By using an angular form, as shown in Fig. 4, the cutter-slide is given a combined horizontal and vertical movement, as required in cutting bevel gears. At the end of the cutting stroke, the cutter is lifted to clear the blank, and during the return stroke, the work is indexed automatically. The index mechanism is first unlocked, and then the indexing ratchet turns the work-spindle until it is again locked for cutting the next tooth space. These indexing movements are con-

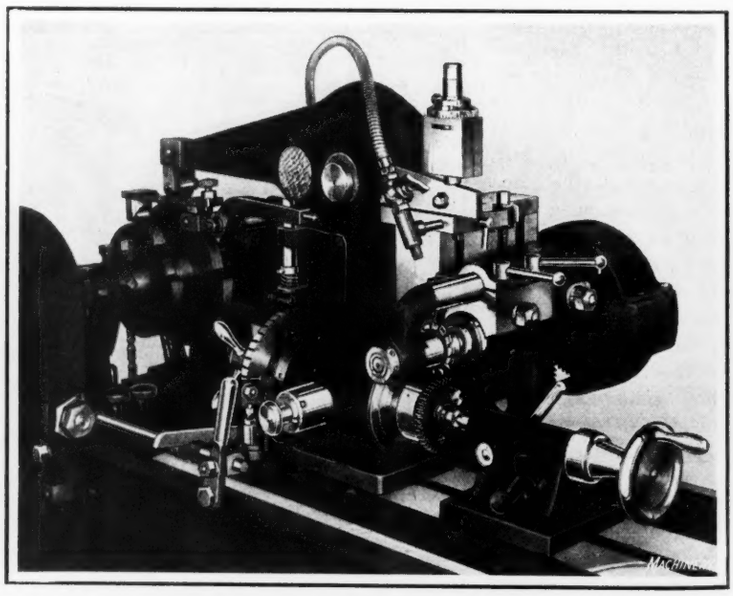


Fig. 4. Cutting Bevel Gear Segments

trolled by additional cams at the rear. The depth of the cut may be regulated by a micrometer adjustment for the finger that bears against the form at the top of the cutter-slide.

The bevel gear segment shown on the machine in Fig. 4 has twenty-two teeth, ¼ inch face width, and an angle of nearly 8¼ degrees. These segments are cut at the rate of 3½ minutes each, which includes the changing time. The segment is mounted on an arbor passing through a special sleeve held in the headstock spindle by a draw-bolt. A horseshoe washer bears against the outer face of the hub, and permits the work to be readily inserted or removed. The arbor is keyed to the sleeve to prevent it from turning when the inner draw-bolt is tightened, and the sleeve is keyed to the headstock spindle to insure accurate registration. The gear blank is locked circumferentially by a stud and set-screw on one side, which forces the opposite side against a stop-pin.

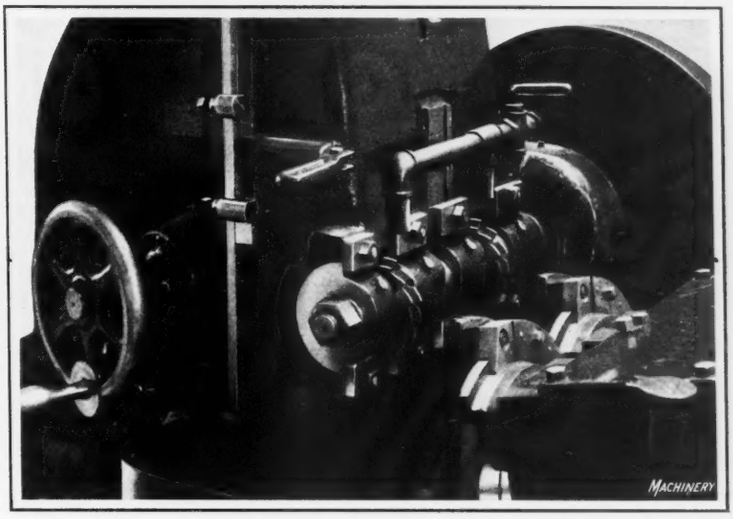


Fig. 5. Cutting Two Bevel Gear Segments simultaneously

A method of cutting two bevel gear segments at one time is illustrated in Fig. 5, which shows a Gould & Eberhardt machine. The cutter-slide of this machine feeds vertically along the face of the column and carries two cutters, as shown in the illustration. The bevel gear segments are held on pivoted arms that form part of the fixture, and these are indexed in unison for milling each successive tooth space. These cast-iron segments have eleven teeth of 5 diametral pitch, and 1¼ inch face width. They are cut at the rate of nine per hour. No attempt was made to produce accurately formed teeth, since this was not necessary.

Cutting Double-angle Bevel Gears

An unusual gear-cutting operation, also performed on a Bilton machine, is shown in Fig. 6. The work is that of cutting double-angle bevel gears. The first part of the gear has an angle of 15 degrees, which changes to an angle of 29 degrees. This double angle is readily milled during one passage of the cutter, by using a double-angle form at the top of the vertical slide. When the cutter is milling the 15-degree section, the 15-degree part of the form is sliding under the finger of the lever arm. Then, as the 29-degree edge of the form, which inclines upward to the left, comes into contact with the finger, the cutter moves down along the corresponding section of the gear. A special stroke cam having the necessary throw is used to feed the ram forward. When the last cut is completed, the feeding mechanism on machines of this type is tripped automatically. The double-angle gears are made of cold-rolled steel and have twenty teeth. Ten gears are cut per hour, which includes changing time. The machine illustrated is one of a battery of four run by one operator.

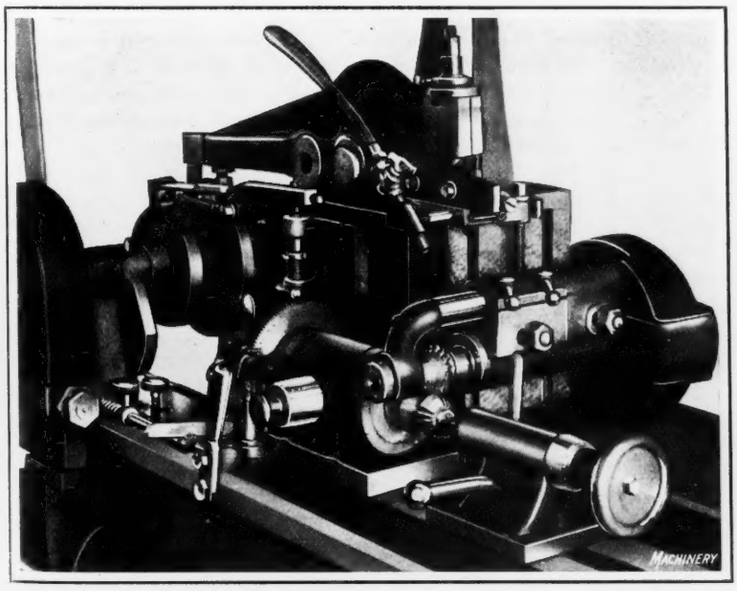


Fig. 6. Cutting a Double-angle Bevel Gear

* * *

THE VALUE OF STANDARDIZATION

In a brief summary prepared by P. G. Agnew, secretary of the American Engineering Standards Committee, 29 W. 39th St., New York City, thirteen specific points are brought out on the value of standardization in the engineering industries, as given in the following:

1. It enables buyer and seller to speak the same language, and makes it possible to compel competitive sellers to do likewise.

2. In thus putting tenders on an easily comparable basis, it promotes fairness in competition, both in domestic and in foreign trade.

3. It lowers unit costs to the public by making mass production possible, as has been so strikingly shown in the case of incandescent lamps and automobiles.

4. By simplifying the carrying of stocks, it makes deliveries quicker and prices lower.

5. It decreases litigation and other factors tending to disorganize industry, the burden of which ultimately falls on the public.

6. It eliminates indecision both in production and utilization—a prolific cause of inefficiency and waste.

7. It stabilizes production as well as employment, by broadening the possible market, and by making it safe for the manufacturer to accumulate stock during periods of slack orders to an extent that would not be safe with a product that was not standardized.

8. By focussing on essentials, it decreases selling expense.

9. By concentrating on fewer lines, it enables more thought and energy to be put into designs, so that they will be more efficient and economical.

10. By bringing out the need of new facts in order to determine what is best, and to secure agreement on most questions, it acts as a powerful stimulus to research and development.

11. It is one of the principal means of getting the results of research and development into actual use in the industries.

12. It helps to eliminate practices that are merely the result of accident or tradition, and that impede development.

13. By concentration on essentials and the consequent suppression of confusing elements intended merely for sales effect, it helps to base competition squarely on efficiency in production and distribution and on intrinsic merit of product.

Buying Tool Steel Performance

By CHARLES M. BROWN, Vice-president and Sales Manager, Colonial Steel Co., Pittsburg, Pa.

THERE is a growing feeling among buyers and users that tool steel ought to be standardized. They want to know more about the varying qualities and differences and reasons why there are so many kinds. And, most of all, they want to find some way of discriminating between competitive makes without the burdensome, annoying, and costly method of trying it out in actual performance. Before saying offhand that this can or cannot be done, there should be a clear understanding of what is expected and demanded of any tool steel after it is ordered.

What does the tool steel manufacturer actually sell? We venture to state that in the majority of cases he does not sell steel at all. In fact, he is often inclined to feel that he is not in the steel business as it is usually known. What he is really engaged in selling is "tool performance." It is the trade custom and has been for many generations, to supply tool steel suitable for the purpose for which it is intended, and the standard trade guarantee is based on this condition. While the order specifies so many bars, and that many bars are actually delivered, this is not what the buyer actually seeks. What he does demand is that a certain specific job requiring tools shall be done successfully in his shop. As a consequence, any successful selling force must have a thorough knowledge of metal-working and machine shop practice. It must be competent to advise and criticise the design and making of tools of every kind; understand the operation and control of gas, oil, and electric heat-treating furnaces; know the proper temperatures for hardening every kind of steel, the best medium and the most successful ways for quenching, and the infinite variations in tempering; and even the setting up and operation of machine tools. All this experience and knowledge —intensified service—is purchased when an order for tool steel is placed with a dependable manufacturer of tool steel.

Should tool steel be bought on the basis of specifications of its chemical composition? This is the question that the author of this article answers. Is the value of a tool steel to the buyer measured by any other standard than by performance, and can performance be made to depend directly upon analysis and composition? The author discusses this subject thoroughly, and answers the questions raised definitely. He shows that composition or analysis alone does not determine the merit of a steel, and points out that it is much easier for the steel manufacturer to make a steel of a given analysis than to make one that will measure up to certain performance requirements.

Should a Buyer Specify the Analysis of Steels?

If tools from a certain brand of steel do not give satisfactory results, the buyer feels justified in demanding an adjustment, unless the seller can prove that the difficulty arises from something in their design, machining, hardening, tempering, or the way in which the tools are put to work, and not in the steel itself. It is then that the tool steel salesman is really called upon to deliver what he has all the time been expected to, and that is, tool performance. Such being the case, it is only right for the salesman to ask the buyer, at the time of ordering, for what purpose the steel is to be used, and then name his price on the grade that he considers will give a satisfactory performance. Almost all tool steel catalogues urge the buyer to specify on every order the purpose for which the steel is to be used. This is not done with a view to manipulating prices or juggling brand names, but rather to make it possible for the tool steel manufacturer to carry out the contract as he is expected to.

The absolute essential, then, before attempting to standardize tool steel or to draw any specification that places limits on analysis or methods of manufacture is to decide definitely what is expected and demanded of the steel after it has been delivered. If the buyer is going to demand a satisfactory tool performance, what will he gain by telling the manufacturer how much carbon or how little phosphorus to put in the steel? On the other hand, should the buyer be willing to relieve the tool steel manufacturer of all responsibility for tool performance, he can simplify his purchasing by adopting an analysis specification; but that is all he can do, for analysis is an indication only and not a proof of quality. This can be seen by considering what the tool steel manufacturer has to do before he decides his product is satisfactory.

Development of High-speed Steels

The differences between the grades and varieties of tool steel are of two kinds: First, those due to the materials used, and second, those due to the methods employed in manufacture. The difference in materials used largely accounts for the various kinds of steel, such as high-speed steel, alloy tool steel and carbon tool steel; and the difference in methods affects the same kinds or grades of steel, as made by different manufacturers. Ancient tool steel was all straight carbon steel, or if it contained any alloy that fact was not known. It is possible that the superior merits of some ancient sword blades are due to the fact that the ores from which they were manufactured contained small percentages of tungsten. The first advance of any practical value over straight carbon steel, and the first successful attempt at combining an alloy or other metal with iron to obtain improved cutting qualities was the manufacture of self-hardening steel by Robert F. Mushet in 1868. This steel contained a comparatively high percentage of carbon, in addition to a high percentage of tungsten. From this tungsten self-hardening steel there has since been developed the more complex high-speed steels of today, which are a combination of iron with chromium, tungsten, vanadium, and occasionally small quantities of other alloys.

As a result of the great increase in cutting qualities of tools made from high-speed steel, many experiments have been made to determine the value of combining other alloys with iron for tool steels, and as a result there are now being produced alloy tool steels containing tungsten, chromium, vanadium, nickel, molybdenum, and other alloys, either singly or in combination. Straight carbon tool steel is a different and more complicated class, and we have a great variation in quality due to differences among manufacturers, both in the raw materials used and in the methods of manufacture. Some carbon tool steel is made from very pure puddled iron, commonly known as "muck bar"; some from puddled iron and tool steel scrap melted together; and in still other cases it may be made entirely from basic open-hearth scrap in the form of plate shearings or punchings.

or from low phosphorus and sulphur basic open-hearth bar remelted in the crucible pot.

Process of Manufacture

In the manufacture, the first step is melting, of which there are three processes—the crucible, which is the oldest; the open-hearth, either basic or acid; and the more recently developed electric process. Large quantities of tool steel are being produced, and have been for years by the open-hearth process. Many think of tool steel as that which is used for metal-cutting purposes only, but there are quantities of other hardened and tempered tools and implements that were formerly made from crucible steel and are now almost entirely made from open-hearth steel. Among these are such tools as plowshares, mowing-machine knives, oil-well drilling tools, mining drills, saws, hatchets, and axes. Wherever the demand for tools and implements has grown to such an extent that a large tonnage of steel is required, it is invariably found that the crucible process is too costly. By careful experimentation and the application of the same care in the manufacture that is applied in melting steel by the crucible process, open-hearth steels of high quality have been developed, and it is probable that this change to a steel which can be melted at a lower cost, will be made wherever the demand is great enough.

The electric process is the newest, and while it has made rapid strides and is successful in many instances, it has not yet been proved that steel melted by this process is as suitable for many purposes as steel melted by the crucible or the open-hearth process. The crucible process is, by comparison with other methods of melting, a hand process and deals with very small units, every lot being melted in units of about 100 pounds which constitute the contents of each crucible. Everything about the process requires close attention. It is, however, strictly a melting and not a refining process, and steel taken out of the furnace will be no purer than that put into it. Consequently, the mere fact that steel has been melted in a crucible does not of itself insure good quality. It must be good before it is melted. Most manufacturers consider that puddled iron or muck bar is the best raw material from which to melt tool steel.

Disadvantages of the Open-hearth and Electric Processes

The disadvantage of the open-hearth process is that, because it has almost universally been used by the steel trade as a tonnage producer, with quality but a secondary consideration, the majority of experienced open-hearth steel men have concentrated their attention on those refinements and processes that tend to give additional tonnage, and have not directed their minds to those refinements that would tend to produce better quality. The fact remains, however, that the tool steel manufacturer, because of his experience gained in the manufacture of steel by the crucible process and his knowledge of the dangers to be met, can produce a really high-grade steel by this process.

The disadvantage of the electric process for tool steel manufacture seems to lie in the fact that the temperatures produced by the electric arcs are extremely high, much higher than is desirable for melting, and as a result some part of the bath is subject to overheating during the melting with a consequent effect on the quality. This is particularly noticeable with plain carbon steels having no addition of alloys that possess higher heat-resisting qualities than iron.

Experience and Carefulness Necessary in Producing Tool Steels

After melting and casting, the ingot must be reduced either to a finished bar or to a billet of a size that can be rerolled. On account of the high carbon content, this operation must be carried out with the greatest care; if at all overheated in forging or rolling, the steel is spoiled. After reducing to billets, it is customary to smooth off the surface either by grinding, or by using pneumatic chipping chisels. All roughness, surface cracks, and seams, if not removed, result in seams in the finished bar. The billets are then rolled into finished sizes, or hammered down. Here again the heating has to be conducted with great care, and, as before if overheated in the process of rolling, or final forging, the steel is spoiled. The usual final step in the manufacture is annealing, and this is a matter of the greatest importance. Steel that is over-annealed is very difficult to harden, and steel that is under-annealed is not only difficult to machine, but besides does not give the maximum production when used in the form of hardened and tempered tools.

All these operations may not be carried out exactly in the same way in different mills, and there are intermediate steps in caring for or protecting the steel, which may vary. Experience and the greatest possible care at all times are necessary to produce a steel that will stand the abrupt transformation that it undergoes in hardening and tempering. Even should two organizations possess the same degree of skill and experience, they will not apply this to the same degree. Great differences will therefore exist in the thoroughness or expertness with which these operations are carried out, and so quality differences are bound to occur in different makes of tool steel. As previously mentioned, these are due, first, to the difference in the materials used, second, to the different methods of manufacture, and third, to the extent to which care is applied in the making.

It is essential before attempting to standardize tool steel, or to draw up any specifications that place limits on analyses or methods of manufacture, to decide definitely what is expected and demanded of the steel after it is delivered. If the buyer's one aim is simply satisfactory tool performance, what does he gain by telling the manufacturer how much carbon or how little phosphorus to put in the steel? On the other hand, if the buyer is willing to relieve the tool steel manufacturer of all responsibility as to tool performance, he can simplify his purchasing by adopting an analysis specification; but this does not insure performance, because analysis is an indication only, and not a proof of quality.

Standardized Compositions of High-speed and Alloy Tool Steels

At present alloy tool steels and high-speed steels are largely standardized. Carbon tool steel is not, because there are too many variables in practice and too wide differences in the requirements that must be met in tools for different purposes. Alloys have very definite characteristics which they impart to the steel, and so it is possible to measure the results obtained by the use of steel containing them. Furthermore, alloy steels are used for comparatively few kinds of tools or operations, and for this reason it has been possible to watch and check up the results. Where it has been proved that the addition of a certain alloy gives improved qualities to the steel, a specification demanding that alloy in an amount definitely fixed within reasonable limits can be made. It is a mistake, however, to suppose that the inclusion of a small percentage of any known alloy will overcome all the troubles in the use of tool steel and the hardening and tempering of tools. But for the sake of simplicity, a standardized schedule dividing steel into types according to the presence of one or more alloys is feasible. In fact, this has already been done to a large extent.

High-speed steel is now made in two general types, the first of which is most common and has a composition about as follows: Carbon, 0.55 to 0.75 per cent; manganese, 0.20 to 0.40 per cent; silicon, 0.10 to 0.30 per cent; chromium, 3 to 4 per cent; tungsten, 16 to 18 per cent; and vanadium, ½ to 1 per cent. There are many different makes of high-speed steel that conform to the standard composition given.

The second type has the same general composition, except that the amount of tungsten is lower, running from about 12 to 14 per cent, and the amount of vanadium higher, being from 1½ to 2 per cent. This type is not so commonly known, but can be obtained in several brands.

Manganese has a marked effect on steel, and as a result the following standard composition has been pretty generally followed for oil-hardening tool steels: Carbon, from 0.80 to 1 per cent; manganese, 1.25 to 1.75 per cent; and silicon, 0.25 to 0.40 per cent. There are other standard types of alloy steel, including one containing a very small percentage of chromium, which is used in the manufacture of carbon twist drills. Another alloy tool steel containing about 1½ per cent tungsten is increasing in favor among tap manufacturers. Others are less widely known; for example, vanadium tool steel, which was made standard by the United States Shipping Board for rivet driving sets.

All these standard types of steel contain one or more alloys on which they depend for marked and valuable characteristics. While different results are obtained from different brands, due to the difference in methods of manufacture and the care with which they are applied, all steels conforming to these types are very similar in characteristics and, generally speaking, will respond to the same method of heat-treatment. A specification of analysis should, therefore, secure a reasonable uniformity of composition, which would, in turn, make possible the adoption of definite methods of heat-treatment.

Conclusion—Working Qualities Versus Analyses

The great bugbear in the trade, however, is the fetish of analysis which many seem to feel can be relied upon to determine whether steel is of satisfactory quality or not. As a matter of fact, this is at present a great drawback to the progress toward standardization which is all the time going on, because analyses do not insure working qualities. The writer maintains that the successful specification must designate some method by which the following qualities of tool steel can be determined: (1) machineability; (2) dependability in hardening and tempering; and (3) ability to do the work for which it is purchased. These are practical things that in the long run always determine which tool steel shall be purchased. There is no benefit in drawing up an analysis unless all three of these things can be definitely procured.

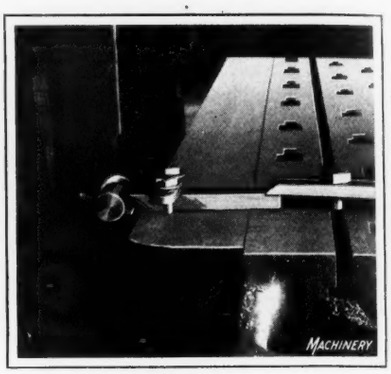
The writer maintains that the choice of manufacturing process should be left to the manufacturer. As an economic proposition, it is desirable that steel be produced by the least expensive method. Hence every manufacturer should be left free to develop any process by which he can turn out a steel that will best meet the three requirements just stated, and should not be confined to fixed methods simply because these have been used in the past; any attempt to so confine him is merely going to hinder the normal development and progress that would otherwise be made.

What the buyer wants is tool performance, and this must never be lost sight of. If he draws up an analysis that is broad enough to include all the kinds of steel that will give good results for the purpose for which it is intended to be used, he has not changed the situation much. But, on the other hand, if he draws up a specification of analysis that is rigidly narrow, he will reduce production to a price basis without respect to quality, because the easiest thing for the tool steel manufacturer is to furnish steel to any given analysis if he makes up his mind to do it. By the use of the electric furnace and manipulation of the slag, it is possible to reduce sulphur and phosphorus contents to any practical limit desired, but it does not follow that steel so made will meet the three requirements that we have stipulated as the basic tests for any tool steel. It is ten times easier to furnish a steel to a given analysis than it is to meet any one of the many shop requirements that ordinarily have to be met.

INCREASING THE WIDTH CAPACITY OF A PLANER

By DONALD A. HAMPSON

A number of castings required in the construction of a machine were found to be so wide that they could not be planed in the largest machine available, which was a heavy 48-inch planer. It was found possible, however, to so arrange all castings on the planer table that the wide portion would be located next to the table surface. When so arranged, the wide part had a height of a little over 2 inches at each side of the table. The castings were a little over 49 inches wide at this point, in the rough, which meant that the distance between the planer uprights should be at least 49½ inches so as to clear the work when the machine was in operation.



Tool-holder clamped to Table for planing Grooves in Uprights

In order to determine if grooves could be planed in the uprights to give the required width, test holes were drilled through them just above the table. These holes showed that sufficient thickness of metal would be left in the uprights even after grooves of the required depth were planed. As all the work done on the planer was light, compared with that for which the planer was originally designed, it was decided to cut the uprights away to a depth of ¾ inch. Naturally, such a procedure would not have been considered for an occasional job, and it was only done in this case because the work promised to be steady throughout the year.

The next thing to decide was how to do the cutting. To remove cast iron to the amount of 1½ by 2 by 54 inches, is not an easy task, especially if a nice looking job is desired. The accompanying illustration shows how this was accomplished. An Armstrong special planer tool-holder was stripped of its head and fitted with one of soft steel carrying a ⅝-inch tool bit in the cutting end. The head was provided with a shoulder and lock-nuts, so that it was a tight fit in the shank but could still be turned with a 20-inch wrench.

This tool was securely clamped to the table, as shown in the illustration. By sweeping the head through an arc, turning it slightly at the forward end of each stroke, it was possible to cut the metal away quite rapidly. After cutting each arc-shaped groove, the tool was moved outward ¼ inch. It required two and one-half days to complete the work, three vertical settings being necessary to make a cut in the uprights of the required depth and height.

* * *

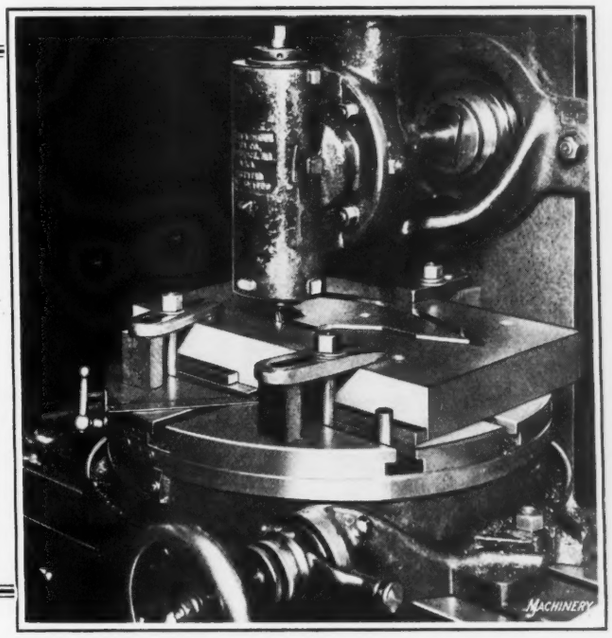
SALES OF MACHINE TOOLS IN JAPAN

The total sales of machine tools in Japan amount to about 30,000,000 yen (approximately $15,000,000) annually. Of these machine tools, about one-third are made in Japan, and two-thirds are imported. In 1920 the total imports of machine tools were just a little short of 20,000 tons. Of the imports in that year, over 80 per cent came from the United States and almost the entire remainder from Great Britain. The imports from Germany, Sweden, France, Switzerland, and Belgium were but slightly over $50,000 in total value. These figures were obtained from a machine tool dealer in Japan, and are based on Japanese government statistics. Figures for 1921 are not yet available, but there was a decided falling off in imports in that year.

Dies for Die-castings

Specific Examples of the Design and Construction of Dies for Making Die-Castings of the More Intricate Types Second of a Series of Articles

By A. G. CARMAN, Chief Metallurgist
Franklin Die-Casting Corporation, Syracuse, N. Y.



TO give some idea of the general principles followed in the design and construction of dies used in the die-casting process, a number of representative dies and castings produced by them will be considered in this article. The first example embodies the general principles governing the construction of dies for producing wheels having raised letters, figures, or characters on their periphery, such as are used in printing presses and tabulating, counting and adding machines, etc.

Fig. 1 shows the two parts of a die used in producing a zinc-base register collar, the upper half of the die being on the right, and the lower half on the left. The casting produced is shown beneath the lower half of the die. Referring to the upper half of the die, *C* represents the slides, ten in number, which carry the numbers and graduations for the periphery of the casting; *D*, the plates having slots in which pins in slides *C* operate to move the slides radially in and out before and after the casting has been formed; *E*, a stationary core with a small core in the center to form the small hole in the center of the casting. Two ejector-pins *F* extend through the core *E* and four ejector-pins *G* act on the rim of the casting. All the ejector-pins are rigidly fastened to an ejector-plate in the upper part of the die and are operated by the two pinions *J*.

In the lower half of the die is an opening *L* for the admission of metal from the pressure chamber of the casting machine to the depression in the die. The darkened area surrounding the depression and extending to the edges of the die is air space milled in the plate to allow the air in the depression of the die to escape. Ten dowel-pins serve the purpose of aligning the two parts of the die, and by passing through holes in the slides *C* lock them and hold them firmly in position while the casting is being formed.

In the lower right-hand corner of Fig. 2, is a detail view of the register collar made by this die. To the left are the plan and elevation of the die. The heavy dark line shows the parting line of the die, and the dotted-line section the casting depression. Letter *L* indicates the channel for the admission of the metal. The stationary core *E* fits into the slotted ring *A*, and this, in turn, fits into the slotted ring *B* in such a way that the slots in *A* and *B* form a continuous radial slot for the cores *C*. The cores *C* are made in two sections and pinned together, as indicated in the detail view of this part. Thus in case the numerals or graduations become injured, it is necessary to make only one new part and not the whole core. The cores *C* are placed in the casting position by rotating the lever *D* clockwise and are withdrawn by a counter-clockwise movement of the lever. *H* represents the ejector-box to which ejector-pins *F* and *G* are attached, and *J* the ejector pinions used to advance the ejector-pins to remove the casting from the die.

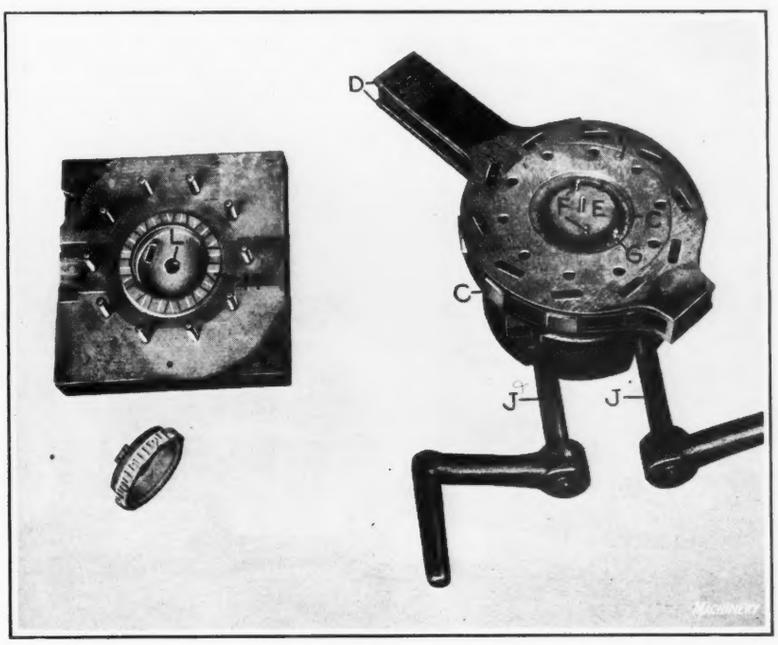


Fig. 1. Die used to produce a Zinc-base Register Collar with Raised Figures on the Periphery

Another die requiring special construction in order to produce a zinc-base casting having an under-cut and external threads is illustrated in Fig. 3. At the right is shown the lower half of the die, at the left the upper half, and at the extreme left the casting. Letters *A* and *B* indicate two cores operated by the pinions *C* and *D*. The cores are fitted with stop-collars which allow them to just meet inside the die and produce a continuous hole through the casting. Another core *F*, operated by the pinion *E*, is also

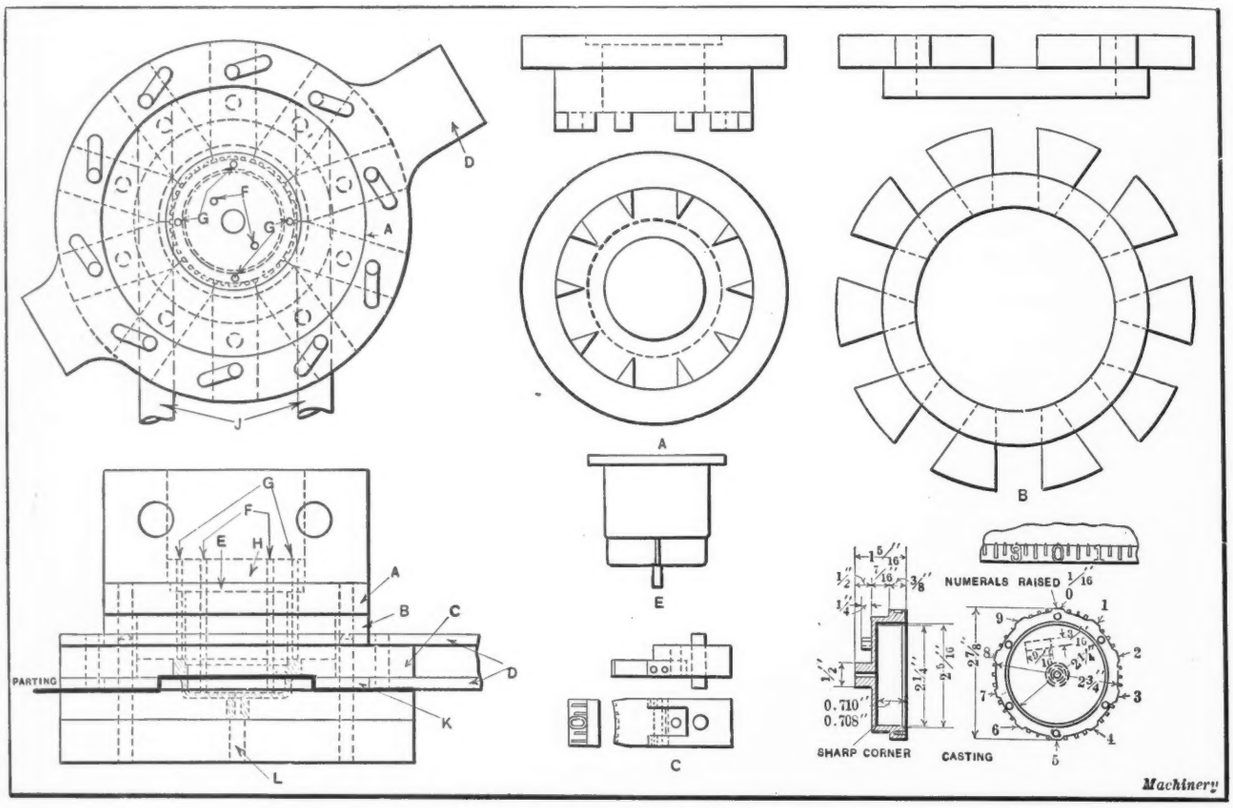


Fig. 2. Detail Views of Die Parts and Casting illustrated in Fig. 1 and Assembly View of Die

provided with a stop-collar that allows the core to just meet core *B*, thereby making a hole in the casting that connects with the hole made by cores *A* and *B*. The large core *G*, operated by the pinion *J*, produces the hollow interior of the casting. The distance this core may advance into the die is regulated by two stop-pins located one on each side of the core.

Two slide cores *L* and *M* operated by toggle levers, form part of the ends and the external threads of the casting. When the die is closed, these two cores are held firmly in their proper place by the dowel-pins that pass through holes in the cores. A stationary core *O* produces the opening in the side of the casting. Five ejector-pins *P* and *Q* are attached to an ejector-plate, two pins engaging the lower part of the casting and three the upper part. The metal enters the die through the opening *S*, and the air in the die passes out through the air space represented by *T*. The die halves are aligned by means of the four dowel-pins on the lower plate. Fig. 4 shows detailed sectional views of the casting. Section *A–A* shows the portion of the casting formed by the cores *A*, *B* and *F* in Fig. 3. Cores *A* and *B* meet to form a continuous passage through the casting, and *F* meets *B* as mentioned to connect the opening in the smaller section with that in the larger part of the casting. Section *B-B* shows the under-cut previously referred to and the external threads cast on the circular flange on one side of the casting.

Fig. 5 shows the plan and elevation of the die, the heavy line representing the parting line of the die and the dotted-line section, the casting depression. On account of the recess previously referred to, the main core *G* is made in two sections, as indicated by the dotted line *H*. The two parts of the core are moved jointly into position by the pinion *J* before the casting has been formed, but only that part of the core below the line *H* is withdrawn from the casting by pinion *J*. The part of the core above the dotted line *H* remains in the casting and is ejected with it, being removed later.

In the next installment of this series of articles, dies for venturi tubes for gas engine mixing chambers and dies for door checks will be shown. The metals used for die-castings will be dealt with in another article, completing the series. In connection with the article on metals used for die-castings, definite compositions will be given, and the possible limits of accuracy for different types of die-castings will also be stated. Other information of value to those who contemplate the use of die-castings in their products will be included.

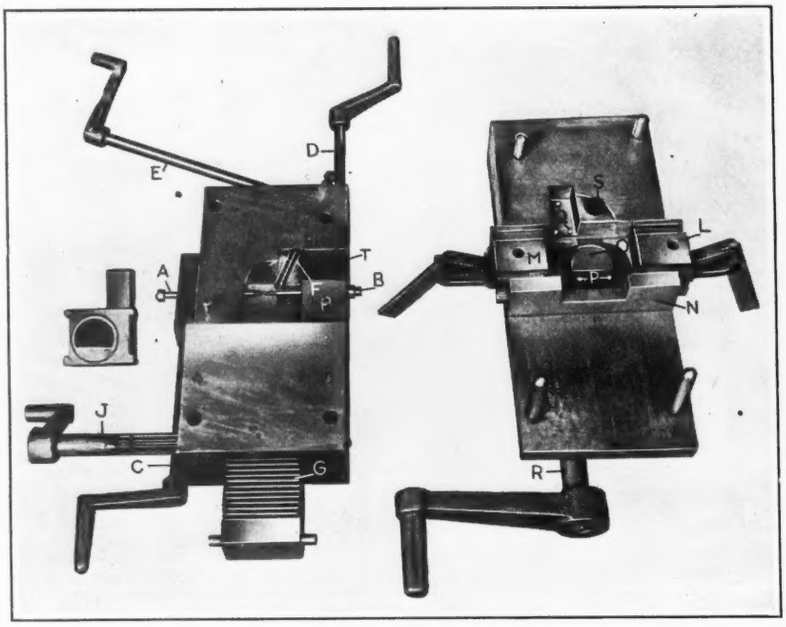


Fig. 3. Die for producing a Zinc-base Instrument Housing

STANDARD TESTS FOR LEATHER BELTING

Standard specifications have recently been adopted for leather belting by a joint committee of the United States Bureau of Standards and the Leather Belting Exchange, of which Louis W. Arny, 417 Forrest Building, Philadelphia, Pa., is secretary. This is the first standard that has been adopted for defining a belt of first quality. The question of quality in leather belting resolves itself into a question of the selection of the part of the hide from which a belting strip shall be cut in order to give the best results.

The new specifications, known as Federal Specifications for Leather Belting, provide for four tests that may be applied in any physical laboratory, covering average tensile strength, stretch, elasticity, and piping. The requirements provide that the average tensile strength of five samples of single belting must be 3750 pounds per square inch, or more, and the minimum strength of any one of these five samples must be 3000 pounds per square inch of cross-section.

With regard to stretch, the average elongation of the five samples at a tensile stress of 2500 pounds per square inch shall not exceed 15 per cent. The belt shall also be suspended in a vertical position, and sufficient weight, including the weight of the clamp, shall be attached to the lower clamp to produce a tensile stress of 750 pounds per square inch of the average cross-section. After fifteen minutes suspension, a section 10 feet long shall not exceed 10 feet 7.2 inches in length (6 per cent stretch).

With regard to elasticity, the clamps used in the previous test shall be removed and the sections allowed to lie loosely on the floor for seventeen hours; after this time the length between the gage marks shall not exceed 10 feet 1.6 inches (1 1/3 per cent stretch). With regard to piping, the specifications require that the leather shall not show wrinkles (commonly called piping) on the grain side when bent through an angle of 180 degrees, grain side in, over forms specified for different grades and thicknesses.

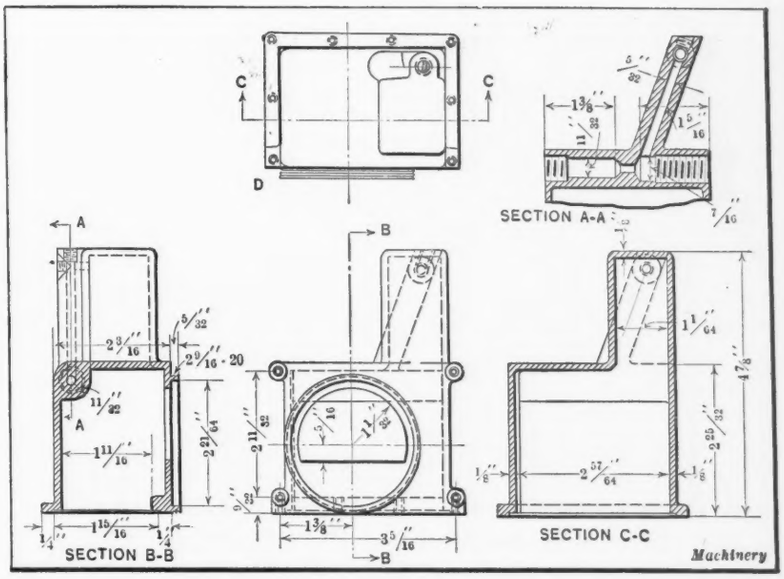


Fig. 4. Detailed View of the Casting made in the Die illustrated in Fig. 3

These four tests will show whether any inferior stock has been used. An unusually high tensile strength, coupled with an excessive stretch and low elasticity, would indicate inferior stock, which would be confirmed by the piping test. A moderate tensile strength, slightly above the specifications, with a stretch within the limitations and an elasticity as stated, indicates a first-class material. These tests differentiate between first and second quality material in leather belting. A copy of the specifications should be in the hands of every concern whose belting purchases are of sufficient importance to make the subject worth while investigating, and may be obtained by addressing the Leather Belting Exchange, Philadelphia, Pa. A number of the leather belting manufacturers already are making belting to comply with these specifications.

* * *

MOTION PICTURES FOR INSTRUCTION PURPOSES

A new lecture course on industrial processes is offered this year for the first time by the Department of Management of the School of Commerce of New York University. The subject matter of the new course is presented entirely by means of motion pictures with supplementary information supplied by the lecturer. This is believed to be the first course of its kind ever given in which moving pictures are used exclusively throughout the entire course. The students are shown many of the more usual processes, machines, operations, and assembling methods found in modern industrial plants. Each picture is accompanied by an adequate explanation of the principles involved. Starting with the basic industries, such as coal and iron mining, and steel making, the course presents in detail the various stages through which the raw materials pass until converted into finished products. One of the pictures relates to the making of a locomotive, beginning at the iron ore mine and following the material through blast furnace and steel mill, forge and foundry, until it reaches the locomotive shop, where machining and assembling operations are shown in detail, and the finished engine finally left on the tracks, ready for its trial run.

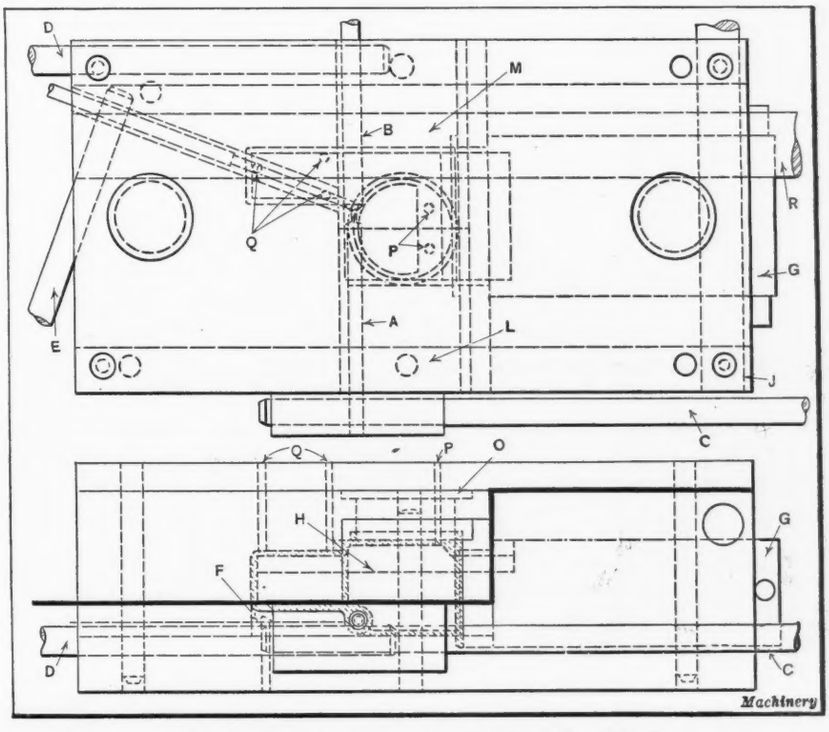
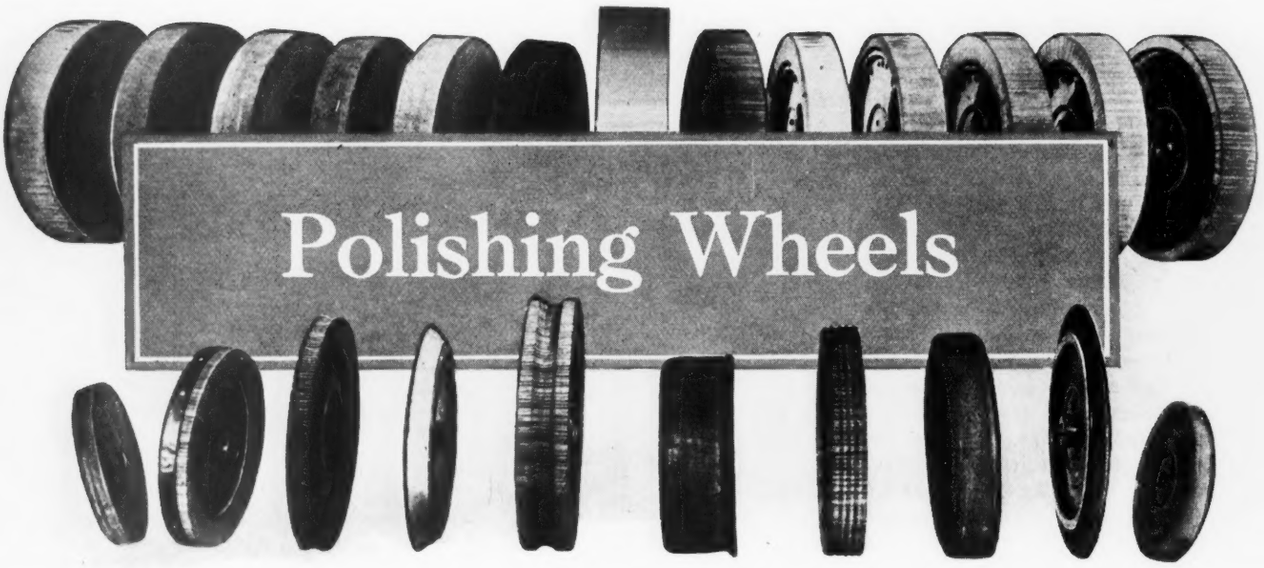


Fig. 5. Assembly View of the Die illustrated in Fig. 3



Polishing Wheels

The Manufacture of Compress Polishing Wheels—Third Article of a Series

By BRADFORD H. DIVINE, President, Divine Bros. Co., Utica, N. Y.,
and President of the Metal Finishers' Equipment Association

THE compress polishing wheel, as mentioned in one of the preceding articles in this series (see November MACHINERY), is a type of wheel in which the material, usually leather or canvas, is placed crosswise of the face of the wheel instead of the wheel being made up of parallel flat disks. The wheel consists of an angular ring, made up of rectangular pieces of material arranged radially and compressed to form a ring or "cushion" of polishing material one or more inches in depth. This cushion is assembled with side plates engaging annular recesses in the compressed ring. The side plates, in turn, are riveted to a hub. The manufacture of compress polishing wheels involves a number of methods that are quite different from those used in making polishing wheels of the solid type. The article in December MACHINERY referred to the solid disk type; the present article will deal specifically with the manufacture of compress polishing wheels.

The material from which the compress polishing wheel is made, even though it may be of the same general quality as that used for a disk wheel, has a decidedly different effect in polishing than the same material in a wheel of disk form. Practically all the materials used in solid disk wheels, such as leather, canvas, walrus hide, sheepskin, felt, and paper, may be used in the construction of compress wheels, but leather and canvas are by far the most commonly used. The object of the use of the different materials is to secure different degrees of density or "cushion" in the face of the wheel. Walrus hide, for example, is more porous and softer than leather, but a compress canvas wheel can be made which has practically the same density on the face as a disk walrus wheel, and which will do the same work equally well or better. Prejudice among old-time polishers is practically the only reason why other materials than leather or canvas are used in the manufacture of the compress style of wheel. The manufacturing process is essentially the same, no matter what the material used.

The leather used in the manufacture of compress polishing wheels is of various kinds. The softer wheels are made from thick, very porous bullneck leather, while the harder wheels are made from thin leather from which both the grain and the flesh side have been removed, and which has the greatest density. It is important that the density of the leather be uniform throughout the entire face of the wheel, and a great deal depends upon the intelligence and experience of the sorter of the leather in selecting that quality which is best adapted for the work to be performed. In addition to the quality of the material, the amount of compression to which the wheel is subjected during its manufacture governs to a large extent the density or "cushion" of the finished wheel.

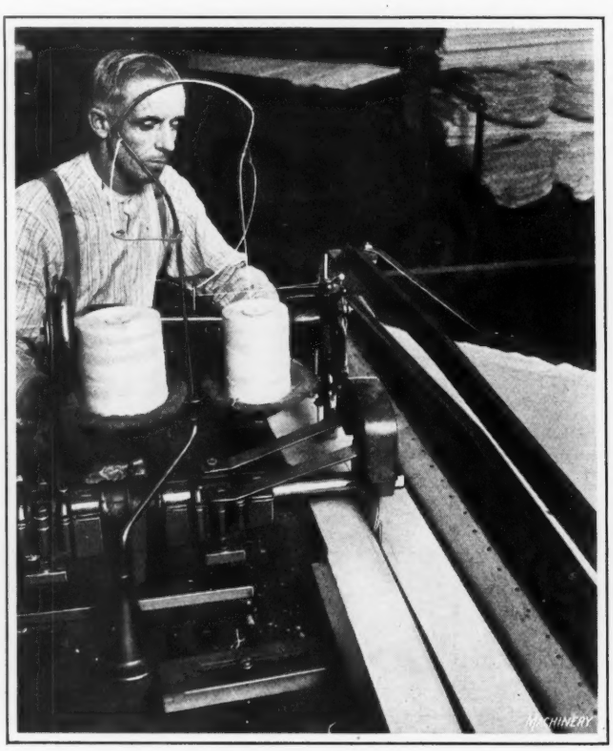


Fig. 1. Sewing the Edges of Strips of Canvas together for Compress Polishing Wheels

The Manufacture of Canvas Compress Wheels

In making canvas compress wheels, the canvas is arranged in layers of suitable thickness for handling during the manufacturing process and cut diagonally into strips, on the bias, so to speak. This step brings the yarns in the canvas at a 45-degree angle to the face of the wheel and avoids any possibility of raveling, which would occur if the weave lay square in relation to the face of the wheel. This position of the material also contributes to the cushion of the wheel.

Fig. 2. Machining the Groove to receive the Edge of the Side Plates

Fig. 3. Assembling the Side Plates and the Cast-iron Hub

The strips of canvas are sewed on the edge to retain the plies in position during the manufacturing process as shown in Fig. 1, and then the strips are cut into blocks of the proper length and width. The blocks are assembled into a circle considerably larger than the finished diameter of the wheel is to be, and after being reduced by compression to the proper diameter, plates with channels on the outer edge are introduced into grooves turned in the sides of the circular canvas cushion near the inner edge. A hub is inserted between the plates, and then the whole mass is forced together in a hydraulic or heavy power press. The plates are next riveted together, balancing tubes are inserted, and the wheel removed from its compression holding apparatus. It is now ready for tooling to shape in a lathe.

Advantages of Compress Wheels

As compared with the disk form of wheel, it will be seen that no adhesive is necessary to hold the material together in the cushion of the wheel; also, there is no possibility of variation in the density of the face of the wheel throughout its working area, due to hard and soft spots in the leather, which will always be present in disk wheels; and inasmuch as the center of the wheel is metal, it is practically impossible for the wheel to change its shape because of atmospheric or other conditions. Furthermore, this form of assembly insures a wheel which will remain round, if properly used by the operator; and it is not reduced in diameter, as are all the disk wheels, because it does not have to be faced off constantly to keep it round and true.

Another advantage of placing the material crosswise of the wheel as described, is that a wheel of this kind can be turned to shape. Much polishing work is done nowadays on formed wheels following the principle of the formed milling cutter. The polishing wheel is turned to the exact shape of the article to be polished. It is not mechanically possible to turn wheels to shape when made of disks; furthermore, they do not retain their shape, as the spread of the disks throws the face out of shape sooner or later. The advantages of the formed wheel are obvious. A formed wheel covers the entire contour, or a portion of the contour, at one time, whereas a flat-faced wheel must work all over the surface to be polished, consuming more time with less accuracy in the finished piece. Often, instead of having several wheels for each particular form, a number of contours are cut into the face of one wheel, so that the operator can finish the job without having to set up another wheel.

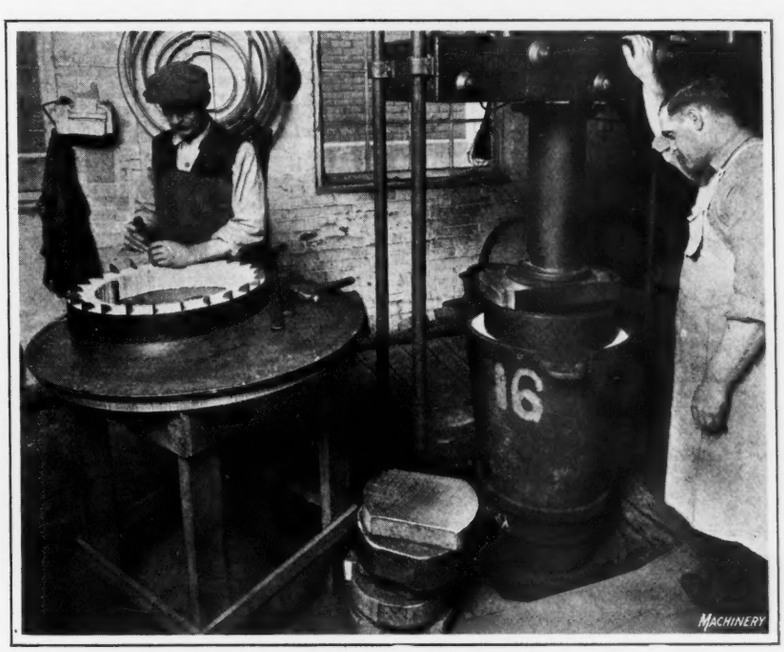


Fig. 4. Assembling the Blocks of Canvas into a Ring preparatory to compressing them with the Equipment shown at the Right

In converting the canvas for polishing wheels from sheet form into strip form, special sewing machines are used, as shown in Fig. 1, the machines having two needles; centrally located between the needles, but behind them there is a slitting saw. The "book" of canvas is placed on an angular traveling top with the edge of the canvas brought to a stop and clamped in place. The stop has a straight edge and is adjustable to give any desired width of strip. The moving top travels backward and forward past the

needles, the edges of the canvas being sewed and the canvas cut into strips at the same time. This insures the strips of canvas having an absolutely straight and square edge like a block of metal, which is necessary for the proper assembly in the wheel of the blocks cut from the strips.

After the strips have been cut into blocks, these blocks are assembled to form a ring by placing them inside a steel band. In the operation of assembling the canvas in the steel bands, shown in Fig. 4, it will be seen that the operator is placing metal spacers between the blocks of canvas in order to give sufficient stability to permit the material to be compressed without collapsing. After compression, the spacers are removed to leave the wheel with the proper density on the face. Many of the wheels are required to be so soft on the face, when finished, that the finger can be inserted between the layers of canvas, while on the other hand other wheels are practically as hard as metal. The number of spacers depends, of course, upon the degree of density required.

The Compressing Process

In the compressing process, the assembling ring containing the canvas, leather, or other material is placed in the top of a large metal cylinder which is tapered. The annular ring of material is forced down through the cylinder by a hydraulic press or a power press. The pressure required varies according to the diameter of the wheel and the width of the face, but ranges from ten tons for the smaller wheels up to about sixty tons for the larger wheels. In the illustration, a ring of material is shown after it has been forced from the band and has started to be compressed in the tapered cylinder. After it has passed through the tapered cylinder, it is held in position in a cast-iron ring which is tooled to fit the lathe in which the ring of canvas or other material is finished on the inside and on both the side faces; at the same time a channel or groove is turned in each side, as shown in Fig. 2, to receive the edge of the side plates.

The operation of assembling the plates and the cast-iron hub riveted between the two plates is shown in Fig. 3, where the operator has already located one flange, placed the hub through the hole of the flange, and is about to put on the other side plate of the wheel. The whole assembly is held together by rivets which are headed with a power riveting machine. Extreme care must be taken not to bend the rivets between the plates, for the strain due to the speed of the polishing wheel would have a tendency to straighten the bent rivets, so that they would become loose, and thus loosen up the whole construction of the wheel. The wheel remains in the cast-iron holding ring or container until it is completely assembled, and there is nothing left to do but machine the face which, of course, is done after the wheel is removed from the holding ring.

Balancing the Wheels

For balancing the wheels, tubes are inserted through the plates, just underneath the inside edge of the polishing material, and a sufficient quantity of one-quarter inch lead wire is placed in them to accurately balance the wheels. If the piece of lead wire needed is shorter than the balancing tube it is upset in the tube, but if it is longer than the tube the ends are turned over and hammered down. In either case, the lead may readily be removed, without damaging the tubes, for use in any subsequent balancing operation. This process is illustrated in Fig. 5. The final work is the truing up of the wheels; this is done by mounting them on their own centers in a lathe, so that they will be mechanically round when finished.

Leather wheels are made in practically the same way as canvas wheels. Leather of uniform density is selected from the same location in a number of hides. Usually a large number of hides are required to produce a sufficient amount of similar material to manufacture an order of wheels. The leather is cut into strips like the canvas, and the strips are cut into rectangles. The leather pieces are often passed through rolls to taper them, and sometimes they are skived to give them a wedge shape and to assist in the radial assembly in the wheel.

Fig. 5. Assembling the Balancing Tubes in the Compress Wheels

Fig. 6. Forming a Concave Face on a Leather Compress Wheel

Recommended Service for Various Compress Wheels

For work ordinarily done on disk bullneck wheels, a compress leather wheel made of medium density is well suited. Such a wheel with a two-inch depth of leather cushion has more spring than one in which the leather is one inch deep. Medium or soft density leather wheels are commonly used for flexible grinding, such as roughing operations on castings, forgings, stamped and drawn metals, etc. Such wheels with narrow faces have greater stiffness than disk wheels and reach better into the necks of valves, grooves of twist drills, and similar places, where the wheels must stand up to the work and be solid enough to hold their shape. For use on disk grinders, compress wheels of leather and canvas are often made in cup form, where the cushion overhangs the face on one side. A band of steel is placed around the circumference of the wheel to hold the

material against the strain of centrifugal force, and the abrasive material is applied on the side face of the wheel. This class of wheel is used to replace cloth and paper disks, for it is much cheaper to reset the wheels with the abrasive and glue than to purchase large disks when only a small area of the disk can be efficiently used.

The compress wheel with leather one inch deep in the polishing cushion is, of course, harder in density than that with the two-inch depth of cushion, and is used for classes of work where a more flexible wheel would not be satisfactory. Such a wheel, hard in density, will maintain the straight edge and surface on fine work, especially such work as sewing machine parts, or other parts having countersunk screw holes which must not be elongated. Typical examples of this class of work are firearm parts, such as pistol handles or rifle frames. This type of wheel is also used largely in the cutlery trade on automatic machines for finishing pocket knife blades where the fineness of the blade requires the most extreme accuracy in the wheel. It is also used for grinding the edges of the blades.

A certain class of polishers insist upon working on the flat side of the leather, as on leather-covered wood wheels; the compress leather wheel lends itself to securing a leather strap to the face of the wheel, which gives the advantages of the strap as well as the accuracy of the compress construction. This is a form of wheel largely used in England.

The compress construction covers a great variety of forms, of cushion densities and depths of cushion, and in the various constructions covers practically every possible range of polishing work, with rare exceptions. It is suitable both for dry polishing and for oil or grease wheels, and has advantages over any other form of wheel for holding sharp corners.

Special Compress Wheels

One rather special form of this wheel is the rubber and duck composition construction, which is manufactured only with the cushion one inch deep and is peculiarly suited for holding very coarse abrasives, such as No. 16 to 24. The abrasive and glue adheres to this composition material with great strength, beyond that of any other polishing wheel. It is peculiarly adapted for grinding castings and forgings, but is not in any sense a finishing wheel. Another very hard wheel is manufactured in the compress construction by using paper or strawboard. Such wheels are often covered with a leather strap, wherever an extremely hard wheel is desired. A good many polishers still insist upon having compress wheels made of felt and walrus hide for some of the finest finishing work.

* * *

THE MACHINE TOOL MARKET IN NEW ZEALAND

By DAVID K. BLAIR, Director, Blair, Reed & Co., Ltd., Wellington, New Zealand

New Zealand is not an industrial country, and as there are very few metal-working shops, the market for machine tools is limited. This must necessarily be so when the population is only about 1,250,000. The Government controls the railroads, and has four large and several small shops in different parts of the country for maintaining the rolling stock. The large shops employ about 1000 men and are fairly well equipped, although a considerable portion of the machinery is quite out of date and should be replaced. Prior to the war, the reorganization of the railroads generally was contemplated. Nothing has yet been done in connection with the shops; but large orders have been placed in England for locomotives and other rolling stock.

There are several well equipped private shops employing from 50 to 200 men. One of these specializes in the manufacture of locomotives, while others make oil engines, pumps, dairy equipment, flax strippers, and agricultural machinery. Some of the small shops confine themselves to the cutting of automobile replacement gears and the manufacture of oil-engine pistons. None of these shops, so far as the writer knows, are equipped with automatic gear-cutting machines, the gear teeth being generally cut by milling, as there is not a sufficient demand for any one size of gear to justify the installation of automatic machines. One of the shops manufactures a post-office machine which is supplied to all parts of the world. This shop also specializes in the maintenance and repair of motion-picture machines and turns out parts equal to any imported.

Machine Tools Mainly of American Manufacture

The total annual demand for machine tools would be somewhat difficult to ascertain, but it is not very great. The chief demand is for lathes up to 12 inches swing, with 6-foot beds, for use in automobile and motorcycle repair shops. Drilling machines are next in importance, and then come tool-grinders and milling machines. Most of the machine tools are of American manufacture, and, if not, follow closely American design, especially in the case of upright drilling machines, tool-grinders, shapers, and milling machines. Shapers, however, are not numerous, and are chiefly found in the repair shops. Quite a number of lathes are provided with electric grinding equipment for finishing cylinders, shafts, etc. There is only a limited number of universal grinding machines—probably not more than thirty in the whole country. There are about a dozen technical schools in New Zealand, and all of these have fairly good shops for the training of students. The bulk of the equipment in these shops is also of American make.

Cutters and Mechanics' Tools

Twist drills, reamers, lathe tools, taps, dies, etc., as a rule, are of American manufacture. Occasionally, British tapping and threading equipment is seen, but in the writer's opinion, it is not as good as that coming from the United States. The bulk of mechanics' tools are also American made, with the exception of wood chisels, which are generally of Sheffield manufacture. Formerly, there were quite a number of German tools, such as bits, pliers, taps, die-stocks and blow-torches, but since the war a tool of German manufacture is rarely seen. Blow-torches now generally come from Sweden.

Wood-saws, carpenters' hammers, and axes are almost universally American-made, and practically all fine measuring instruments, such as micrometers, come from the United States. New Zealand has quite a number of fine large fruit-canning establishments, and in these, the equipment is also almost entirely American. Only rarely is a British or Australian machine seen.

Duty on Imported Machinery

For the last few years about 60 per cent of all machines and tools imported into New Zealand have come from the United States, the remaining 40 per cent being divided among British and foreign manufacturers. New tariff laws which went into effect last June considerably changed the duty on imports. Under the old tariff, machinery and mechanics' tools were admitted free, irrespective of the country from which they were imported, but now only British products are admitted free. Foreign products are taxed to the extent of approximately 10 per cent of their value. An additional 1 per cent primage tax is applied both on free and dutiable goods.

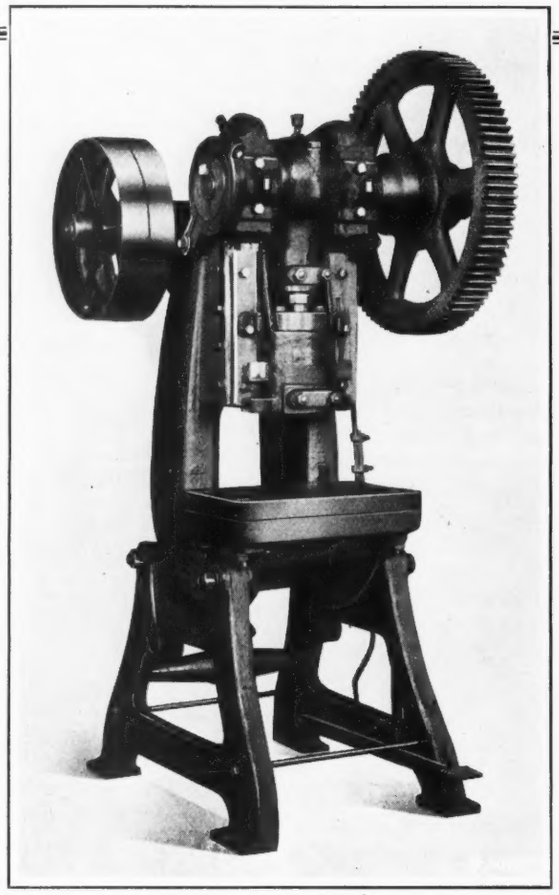
The conclusions here given are the result of observations extending over the twenty-three year period during which the concern with which the writer is connected—a distinctly New Zealand organization—has been selling machine tools in New Zealand.

* * *

The Dutch East Indies in 1921 absorbed more than four times as much machinery as in 1911. During that period the share of this business secured by America has expanded from 264,000 to 5,701,000 guilders (1 guilder = $0.402).

Design of Inclinable Power Presses

By P. A. FRIEDELL



AMONG the industries using power presses to the greatest extent are those producing automobiles and household utensils. Automobile parts produced in power presses include the frame, axle housings, radiator, hood, fenders, brake-drums, wheel hubs, disk wheels, and body. Power presses can also be used to advantage in many other lines of manufacture. Numerous articles which were formerly iron, steel, malleable-iron, or brass castings, are now made in power presses from sheet metal. The sheet-metal parts are almost invariably stronger, lighter, and more uniform, as well as cheaper to make. Different metals can be drawn, formed, and otherwise operated upon in power presses of various styles, each of which has been developed to meet some peculiar demand. This article will call attention to the most common types of power presses, and the work for which each type is especially adapted. It will also give methods of calculating the dimensions of important members entering into the construction of inclinable power presses. Subsequent articles will supplement this information.

Common Types of Power Presses

Power presses are generally classified according to some characteristic, although it cannot be said that the names applied are always appropriate or self-explanatory.

Inclinable Power Presses—Presses of this class are so designated from the fact that the upper part of the frame may be inclined at will to allow finished parts to slide from the die through the action of gravity. This type of press may also be used with the inclinable member in the vertical position. Inclinable power presses are generally of the gap type. The class of work for which they are suited will be considered later in detail.

Inclined Presses—These presses have the frame built in a fixed, inclined position, and are thus non-adjustable. Most all types of presses can be built with an inclined frame.

Horning and Wiring Presses—This type of press is constructed in such a manner that a horn can be fitted in place of the customary bed to permit operations to be performed on tubular parts, such as pipe, cans, etc. An adjustable table may be substituted for the horn to facilitate wiring and other operations requiring high dies.

Arch Power Presses—This class includes presses built with a wide bed and arched frame, and a comparatively small slide. Presses of this kind are recommended mainly for large blanking work or shallow forming operations on the lighter gages of metal.

This is the first of a number of articles on the design of power presses, showing the application of formulas to a specific design of inclinable power press. The present article deals with the crankshaft, main bearings, slide or ram, and connection between the crankshaft and slide. The next article will take up the design of the gibs, frame, and flywheel of an inclinable power press.

Straight-sided Presses—Presses of this type have neither a gap nor arch in the frame. This style is suitable for heavy blanking, piercing, forming, redrawing, reducing, and bending. It is sometimes built with a special slide on the outside of one housing, the slide being operated from the corresponding end of the crankshaft. This slide is used for punching holes, cutting off, or trimming. When a press is so equipped, it is called a straight-sided trimming press. The term "straight-sided" also implies that the press has a single crank.

Double-crank Presses—These presses have the slide operated by two cranks. In other respects, they are similar to straight-sided presses, but they are not recommended for redrawing or bending operations unless especially constructed for the purpose. They are well adapted for shallow drawing operations when equipped with a spring or air-operated blank-holder.

Gap Presses—This type of press is built with a gap or throat through the frame so that the stock can be fed from side to side or from front to back. With the exception of the gap, they are similar to straight-sided or double-crank presses.

Embossing or Knuckle-joint Presses—This class comprises presses intended for heavy operations, such as embossing coins and silverware. Presses of this kind are also adapted for extrusion processes.

Drawing Presses—Presses of this type are usually constructed with two slides called the "plunger" and the "blank-holder," although they are also occasionally built with a bottom drawing slide. The plunger is operated directly by the crankshaft, and the blank-holder and bottom drawing slides through cranks and links (toggle type) or cams. This type of press is extensively used for drawing cylindrical parts from sheet metal. Toggle drawing presses are made with both single and double crankshafts.

Numerous other names are given to power presses, but they all represent some modification of the types referred to. All power presses should be selected to meet the maximum tonnage likely to be imposed, and should have a sufficient stroke for the work to be done. The die space, which is another important consideration, should be

ample. Filler pieces can always be placed under the die, or a heavy bolster can be used.

The Inclinable Power Press

The inclinable power press is one of the most widely used types. It is particularly adapted for blanking, piercing, forming, and shallow drawing operations on household utensils, small automobile parts, and many other articles, as well as light embossing operations on jewelry, etc. An inclinable power press of typical design is shown in the heading illustration. Presses of this type are generally built in sizes having capacities ranging from two to seventy-five tons. A press of greater capacity than the maximum mentioned would be so heavy as to be difficult to incline by means of the hand-operated mechanism with which these presses are usually furnished.

The inclinable power press is particularly suitable for the automatic production of small parts when it is equipped with a feeding arrangement adapted to the part being produced. For the first operation on a given part the stock is usually fed to the dies in the form of a ribbon or strip by either a single or a double roll feed. Very high production rates can be obtained in this manner, it being frequently possible to produce completed or partly completed parts at the rate of 150 per minute. Other styles of feeds used for succeeding operations include dial, hopper, and finger mechanisms.

Designing an Inclinable Power Press

The first consideration in the design of a power press, after the tonnage capacity, stroke, and die space have been decided upon, is the crankshaft. The dimensions of this important member should be calculated according to the method explained in the article entitled "Designing Power Press Crankshafts," which was published in December MACHINERY. The formulas given in that article will be here employed in determining the dimensions of a crankshaft for a single-crank power press of 50-ton capacity, having a two-inch stroke. This crankshaft is to be of the design illustrated in Fig. 1. The trial diameter $d = \sqrt[3]{\frac{50}{3}} = 4.08$ or 4⅛ inches. The trial diameter D should be such that the area of a circle of this diameter would be about 50 per cent greater than the area of a circle of diameter d. By using the tables of circumferences and areas of circles given in MACHINERY'S HANDBOOK, the trial value for diameter D will be found to be 5⅛ inches.

$R = 0.1D = 0.1 \times 5.125 = 0.51$ or ½ inch

According to the first method in the previous article,

$E = (50 \div 2D) + 0.2D = 4.878 + 1.025 =$ about 6 inches

$$E \text{ (second method)} = \sqrt{2\left(\sqrt{\frac{P}{5}} + \tfrac{1}{4}\right)^2} + \tfrac{3}{4} + 2R =$$

$$\sqrt{2\left(\sqrt{\frac{50}{5}} + \tfrac{1}{4}\right)^2} + \tfrac{3}{4} + 1 = \text{about } 6\tfrac{5}{8} \text{ inches}$$

As the dimension obtained by the second method exceeds that of the first, the second figure should be taken.

$C = 0.6d = 0.6 \times 4.125 = 2.47$ or 2½ inches

$F = 0.1d = 0.1 \times 4.125 = 0.4$ or 7/16 inch

Therefore, $B = 6\frac{5}{8} + 5 = 11\frac{5}{8}$ inches, and $L = 11\frac{5}{8} + \frac{7}{8} = 12\frac{1}{2}$ inches.

As the crankshaft is to be designed to receive the maximum load with the axis of the crank at a position 1 inch distant from the vertical center line of the crankshaft bearings, the twisting moment equals 100,000 × 1 or 100,000 inch-pounds. Then, the correct diameter of the crankshaft bearings may be determined as follows:

$$d = \sqrt{\left(1.72\sqrt[3]{\frac{T}{10{,}000}}\right)^2 + \frac{Q}{10{,}000}} =$$

$$\sqrt{\left(1.72\sqrt[3]{\frac{100{,}000}{10{,}000}}\right)^2 + \frac{50{,}000}{10{,}000}} = 4.328 \text{ or } 4\tfrac{3}{8} \text{ inches}$$

The bending moment on the crankpin is as follows:

$$M = \frac{W}{4}\left(L - \frac{B}{2}\right) = \frac{100{,}000 \times 6.68}{4} = 167{,}000 \text{ inch-pounds}$$

Then the correct diameter D of crankpin may be determined from the following:

$$D = \sqrt[3]{\frac{32M}{\pi S}} = \sqrt[3]{\frac{32 \times 167{,}000}{3.1416 \times 10{,}000}} = 5.54 \text{ or } 5\ 9/16 \text{ inches}$$

Next,

$O = D + 2R = 5.56 + (2 \times 0.5) = 6\ 9/16$ inches

$$H = \frac{D + d + 2t}{2} + 2R = \frac{5.56 + 4.375 + 2}{2} + 1 = 7 \text{ in.}$$

$G = 1.75d = 1.75 \times 4.375 = 7.65$ or 7 11/16 inches

The distance across the main bearings of the press would then equal

$B + 2G = 11\frac{5}{8} + 15\frac{3}{8} = 27$ inches

$d_2 = d - 1/64 = 4\ 23/64$ inches

$d_3 = d - 1/32 = 4\ 11/32$ inches

Length J should be made to suit the type of clutch used.

Length K, which is the allowance for the hub of a clutch gear or flywheel should not be less than $2d$. Thus K (minimum) $= 2 \times 4.375 = 8\frac{3}{4}$ inches.

Length I depends upon the dimension of the brake or outside crank for automatically feeding the stock, which may be mounted on this end of the crankshaft.

Determining the Dimensions of the Main Bearing Caps

The design of the main bearing caps for the crankshaft will be assumed to be as illustrated at X, Fig. 2. It is preferable to set the bearing caps with the machined surfaces that contact with the bearing boxes of the frame, at an angle of 30 degrees from the vertical in such a way that the thrust of the crankshaft will be directed on the solid boxes of the frame instead of toward the dividing line of the caps and the boxes. The caps should each be securely attached to the frame by means of four stud bolts. The bolt center distance C should be as small as possible, in order to reduce the bending stresses which tend to break the cap.

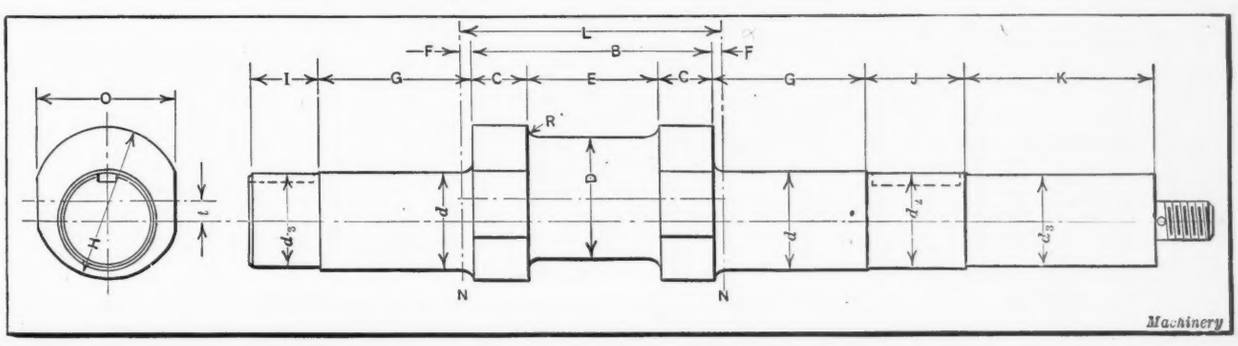


Fig. 1. Dimensions to be calculated in designing a Single Crankshaft for an Inclinable Power Press

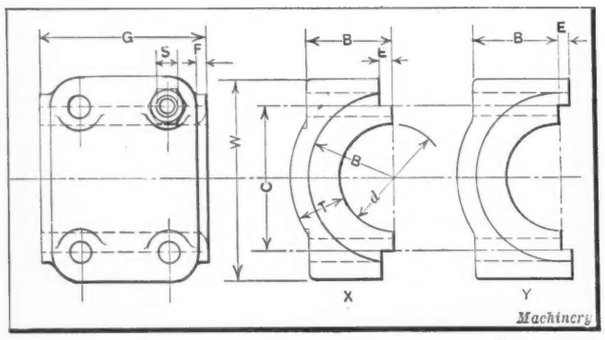


Fig. 2. Types of Caps Suitable for the Main Bearings of the Crankshaft and the Connection

The bearings should be carefully scraped and properly grooved to insure adequate lubrication. Iron castings make very satisfactory bearing caps.

By means of the following formulas, bearings of minimum weight for withstanding the load to be imposed upon them, may be readily designed. The letters of these formulas correspond to similar letters in Fig. 2, and dimension d in this illustration corresponds to dimension d in Fig. 1. S represents the bolt diameter.

$S = 0.15d + 0.25 = (0.15 \times 4.375) + 0.25 = 0.91$ or $\frac{7}{8}$ inch

$C = 1.25d + 0.5 = (1.25 \times 4.375) + 0.5 = 5.97$ or 6 inches

$W = 1.7d + 0.75 = (1.7 \times 4.375) + 0.75 = 8.18$ or 8 3/16 in.

$T = 0.45d = 0.45 \times 4.375 = 1.97$ or 2 inches

$B = 0.8d = 0.8 \times 4.375 = 3.5$ inches

E and $F = 0.125d = 0.125 \times 4.375 = 0.547$ or 9/16 inch

Length G would be made to suit the crankshaft, and in this case corresponds to dimension G, Fig. 1, or 7 11/16 in.

Proportioning the Connection

The connection casting employed for transmitting the power of the crankshaft to the slide or ram will next be proportioned. It is desirable to make this part as light as possible; yet strength must not be sacrificed for weight. A well proportioned connection is essential to continuous operation of a press; otherwise considerable trouble is likely to be encountered through breakage of the connection or stripping of the threads in its tapped hole or on the screw by means of which it is fastened to the slide. The connection cap should be designed by applying the same formulas used in proportioning the main bearing caps, value D in Fig. 1 being used for value d in Fig. 2. The type of cap shown at Y in Fig. 2 is the more satisfactory for the connection, because it and the connection tend to support each other when the load is imposed on them.

A suitable clamping arrangement must be provided on the connection for securely clamping the screw employed in attaching it to the slide. Without a satisfactory clamp, accidental adjustment of the slide may take place, or stripping of the threads due to play between the connection and the connection screw. With the design shown in Fig. 3, the screw is clamped by simply tightening up two bolts. This design is most satisfactory for presses up to about 50 tons capacity. The cap design illustrated in Fig. 4 is more satisfactory for larger presses, on which it is rather difficult to spring a split connection sufficiently to insure proper clamping of the screw.

It will be assumed that the press being designed is to have a split connection. The procedure followed in determining the different dimensions of this member may then be presented. Dimension E, Fig. 3, should be made equal to dimension E, Fig. 1, or 6⅝ inches.

$$F = \sqrt{\frac{P}{5}} + \frac{1}{4}$$

in which F = diameter of tapped hole for connection screw; and P = capacity of press in tons.

Thus

$$F = \sqrt{\frac{50}{5}} + \frac{1}{4} = 3.41 \text{ or } 3\frac{1}{2} \text{ inches}$$

The number of threads per inch on any connection screw should not be less than 3, because with a thread of too large a pitch, too great an amount of effort is required for adjusting the slide. All connection screws from 2½ to 6 inches in diameter should be made with 4 threads per inch. Therefore, as the connection screw for the press being designed is 3½ inches in diameter it should have 4 threads per inch.

When the connection is an iron casting,

$U = \sqrt{2F^3} + \frac{3}{4} = \sqrt{2 \times 3.5 \times 3.5} + 0.75 = 5.7$ or 5¾ inches

$S = 0.15D + 0.25 = (0.15 \times 5.56) + 0.25 = 1.08$, say 1 inch

$H = 0.25D = 0.25 \times 5.56 = 1.39$ or 1⅜ inches

$J = 0.85D + 0.375 = (0.85 \times 5.56) + 0.375 = 5.10$ or 5⅛ in.

M = not less than $0.25D = 0.25 \times 5.56 = 1.39$ or 1⅜ inches

N (amount of adjustment) $= 0.5d$ (Fig. 1) = say 2 inches

$O = 1.1F + S = (1.1 \times 3.5) + 1 = 4.85$ or 4⅞ inches

K = at least $2F = 2 \times 3.5 = 7$ inches

The dimensions of the connection shown in Fig. 4 should be calculated in the same manner as those for the split connection, Fig. 3, except that K for the connection in Fig. 4 should not be less than $2.5F$. Also $V = 3S$ and $X = 1/16$ inch. It is advisable to shim up the clamping cap on this connection while the connection is being bored and tapped. Length G of both connections varies according to the stroke, die space, etc. The minimum dimension for length G in Fig. 3 may be found as follows:

$$G \text{ (minimum)} = 2F + 0.75D + N = (2 \times 3.5) + (0.75 \times 5.56) + 2 = 13\ 3/16 \text{ inches}$$

The minimum length G of the connection in Fig. 4 would be as much greater than the length of the connection in Fig. 3 as the difference between dimensions K of the two connections. Therefore, in all instances where a short connection is desirable and the capacity of the press is 50 tons or less, the design illustrated in Fig. 3 can be safely made shorter than that illustrated in Fig. 4.

Connection Screw and Ball Cap

The simplest form of screw for attaching the connection to the slide, and the one that proves most satisfactory for presses on which the load per crank is not in excess of 200 tons, is the ball type. Such a screw is shown in Fig. 5, attached to the slide by means of a ball cap. For presses of greater capacity than the maximum mentioned, a double connection should be used, in which case the design of the screw would be different.

The following formulas apply to the connection screw shown in Fig. 5. In calculating the dimensions of the connection for the press under consideration, it was found that the screw should be 3½ inches in diameter and have 4 threads per inch.

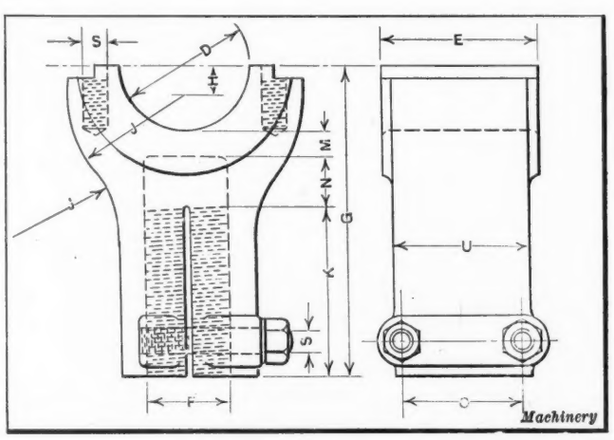


Fig. 3. Connection Design in which the Connection Screw is clamped by springing the Split End of the Casting

Then,

$$N = K + N \text{ (Fig. 3)} = 7 + 2 = 9 \text{ inches}$$

$$O = \sqrt{\frac{F^2}{2}} = \sqrt{\frac{3.5 \times 3.5}{2}} = 2.47 \text{ or } 2\tfrac{1}{2} \text{ inches}$$

$$d = \sqrt{\frac{P}{2}} = \sqrt{25} = 5 \text{ inches}$$

S = same as S, Fig. 3

L (minimum) $= 1.5F + S = (1.5 \times 3.5) + 1 = 6\tfrac{1}{4}$ inches

X (distance across corner of hexagonal section of screw) $= F$ approximately but should not be greater than this dimension. The distance across the flats of this hexagonal section should approximate $0.866F$. Thus, $0.866 \times 3.5 = 3.03$ or $3\tfrac{1}{8}$ inches. A hexagonal section of this dimension across flats will receive a standard 2-inch wrench. The ball end should be scraped to fit the socket and the cap, and should be provided with oil-grooves. The connection screw should preferably be made from 0.40 to 0.50 per cent carbon open-hearth steel. It must be properly fitted to the tapped hole of the connection to prevent binding and facilitate adjustment of the slide.

The ball cap should be a fine-grained iron casting, bored and scraped true to the ball end of the screw. Dimension I should equal diameter F, and the dimension Q should be the same as diameter d. The central hole in the cap leading to the ball seat must be tapered to allow the screw to follow the sidewise motions of the connection. Bolt diameter S should be the same as the bolt diameter on the connection cap, because the ball cap supports practically the same load as the connection cap.

Other dimensions are determined as follows:

$C = d + 2S = 5 + (2 \times 1) = 7$ inches

$D = d + 4.25S = 5 + (4.25 \times 1) = 9\tfrac{1}{4}$ inches

$H = F = 3\tfrac{1}{2}$ inches

Slide or Ram Design

The width and length of the slide or ram of a power press vary to some extent on machines of different makes; however, it will be found that a slide of the dimensions obtained in the manner here given will prove satisfactory in practically all designs of inclinable presses. It is always desirable to keep the weight of the slide as low as possible, because the lighter the reciprocating parts, the less the amount of braking that will be required, and consequently the lower the power consumption. However, as in designing all other machine parts, strength should not be sacrificed for weight. It is advisable to core out metal which can be spared without weakening the slide.

On inclinable presses the slide is usually provided with either a round or a square hole to receive the shank of the punching member. The square hole is more satisfactory, as a rule, for both round or square shanks. A square-hole

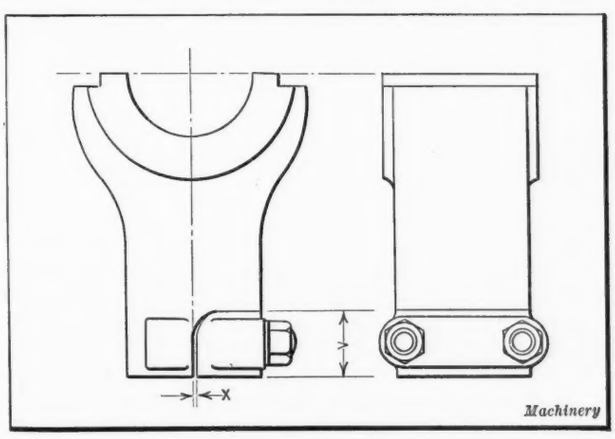


Fig. 4. Construction of Connection employed on Large Presses, the Screw being clamped by Means of a Cap

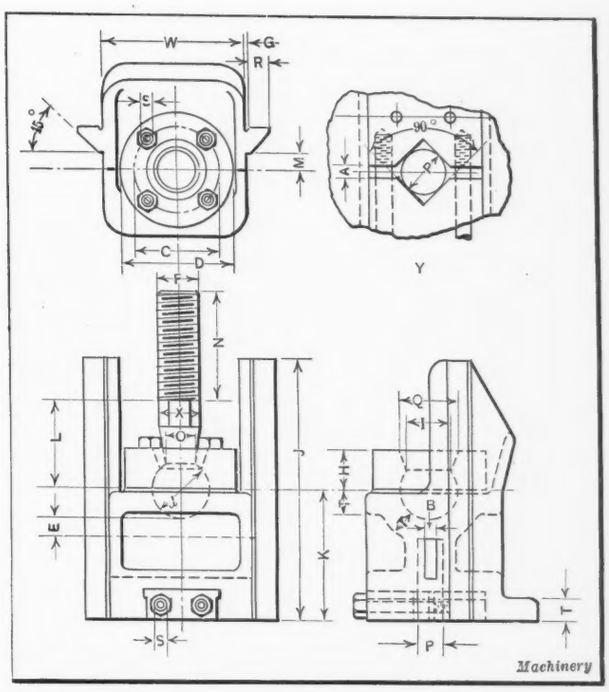


Fig. 5. Typical Design of Ball-type Connection Screw and Slide or Ram

clamp will grip a round shank at four points, while a round-hole clamp will grip the shank at only two points. A square-hole clamp can also be used for punch shanks that are not of standard size, whereas the round-hole clamp will not prove satisfactory for any shank of a different size from that for which it was made. One method of designing a square-hole clamp is shown at Y, Fig. 5, which is the design incorporated in the slide illustrated. The clamp alone is relied upon to hold the punch in position. Another good design, where round punch shanks are employed, is to make either the front or rear clamping block flat, and to provide a 90-degree vee in the second block. This design gives a three-point contact and is more nearly universal than any other type.

Dimension P (diameter of the punch shank) should equal approximately one-third the crankpin diameter; thus $P = 0.333 \times 5.56 = 1.85$, or 2 inches. A cored slot of width B is provided to permit the use of a knock-out bar for forcing slugs or completed parts from the punch.

$B = 0.5P = 0.5 \times 2 = 1$ inch

$T = 0.4d = 0.4 \times 5 = 2$ inches

E (minimum) = not less than M, Fig. 3 $= 1\tfrac{3}{8}$ inches

S = same as S in Fig. 3 $= 1$ inch

W (minimum) $= d + 7S = 5 + (7 \times 1) = 12$ inches

$G = 0.25S = 0.25 \times 1 = \tfrac{1}{4}$ inch

J = twice the crankpin diameter D, Fig. 1 + 12 inches $= (2 \times 5.56) + 12 = 23\tfrac{1}{8}$ inches

$R = 0.08J = 0.08 \times 23.125 = 1.85$ or $1\tfrac{7}{8}$ inches

$K = 0.5J = 0.5 \times 23.125 = 11\ 9/16$ inches

$M = 0.6B + S = (0.6 \times 1) + 1 = 1.6$ or $1\tfrac{5}{8}$ inches

On a slide having the shank clamping arrangement of the design shown at Y, dimension A should equal $\tfrac{1}{4}P$. The bearing surfaces of the slide gibs should be scraped and provided with oil-grooves.

* * *

HOW SHIPPERS CAN HELP MOVE FREIGHT

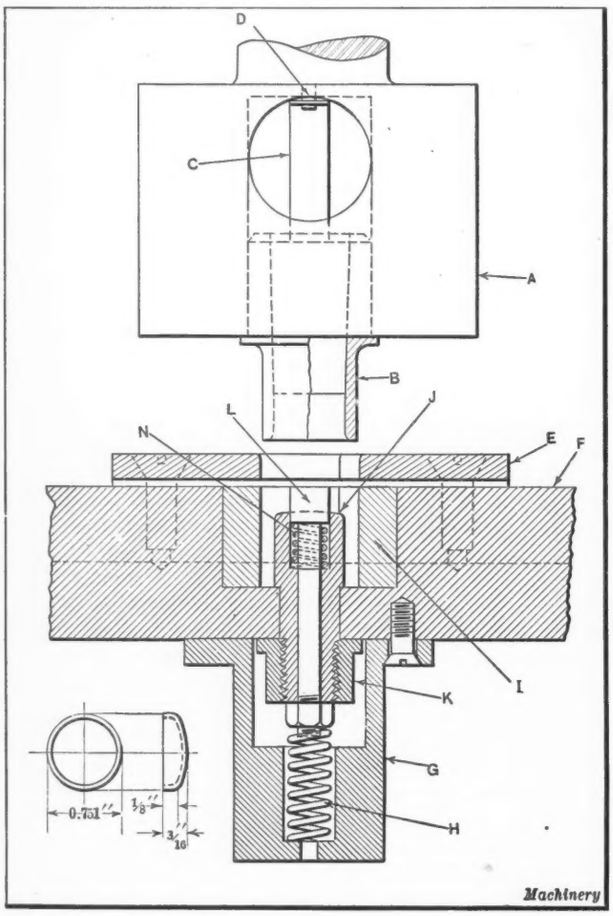
1. Do not order more cars than can be loaded promptly.
2. Load in one day.
3. Load light-weight or bulky freight to the full cubical capacity of the car.
4. Work a little over-time in the evening to finish loading.
5. Do not reject cars for small defects which the station agent or his helper can repair in a few minutes.

BLANKING AND FORMING DIE

By CHARLES E. FITZGERALD

Small cup-shaped parts can be produced by using one die for blanking and another for forming. When such parts are required in large quantities, however, it is generally more economical to use a combination die that blanks and forms one piece at each stroke of the press. A die of this type designed by the writer for use on a No. 3 Niagara press is shown in the accompanying illustration. The shape and dimensions of the work are shown by the view in the lower left-hand corner.

It was necessary that the outside diameter of the work be held accurately to size, as the finished cups were required



Blanking and Forming Die for Cup-shaped Parts

to be a good press fit in a counterbored hole 0.749 inch in diameter by 3/16 inch deep. When pressed into place, the face of the cup was required to be flush with the surface of the counterbored part.

The press on which the die was mounted operated at a speed of 125 strokes a minute, but as short lengths of stock were being used, production was cut down somewhat by the time lost in changing strips. Disregarding the time lost in this manner, the production rate was calculated to be about 100 pieces a minute, or 6000 pieces an hour. About 100,000 pieces were produced on the first run, after which the dies were ground.

Construction of Die

The hole in the lower end of holder *A* is a press fit on the shank of the forming and blanking punch *B*. The upper end of part *A* has a shank which fits into the ram of the press. Punch *B* is hardened and ground on the inside to a diameter of 0.750 inch, and on the outside to a diameter of 0.9375 inch. As the diameter of the outside of the punch determines the size of the cup, it must be finished accurately to size. Spring *C* is held in position at one end by pin *D*, while the other end is sprung into place against the upper end of punch *B*. The spring is thus curved or bent to such a shape that it guides the finished parts out through the vent in part *A* at the back of the press. As the parts leave the vent they fall into a chute which carries them away from the press.

The stripper plate *E* is held in position on die-block *F* by screws and dowels. The hole in the stripper plate through which the punch passes is about 0.015 inch larger than the outside diameter of the punch. This gives ample clearance for the punch, and at the same time is small enough to prevent the stock from buckling on the upward or stripping stroke of the press. Die-block *F* is of cast iron, and is bored out to a press fit for the hardened and ground die *I*. The hole in the die is ground straight and held to a plug fit, being 0.939 inch in diameter, so that no draft is necessary. The depth of the die seat in the die-block is equal to the length of the die so that the upper surfaces of these two members are flush. This presents a smooth surface over which the stock slides freely. The hole in punch *B* has a draft of 2 degrees starting 7/16 inch back from its face.

Part *G* is a casing which contains the lower spring *H*. This spring and spring *N* prevent the formed parts from sticking on the forming post *J*. The forming post is ground on the outside to a diameter of 0.700 inch at the end, tapering back to 0.702 inch. This 0.002 inch draft does not affect the diameter of the cup appreciably and is provided simply to prevent the cup from sticking on the forming post. The shank of the forming post is ground to a press fit in die-block *F*, and is held in place by lock-nut *K*. The knock-out pin *L*, which is acted upon by springs *H* and *N*, forces the work into the hole in punch *B* and off forming post *J*. On the succeeding down stroke of the press the work is forced into the relieved or tapered section in the forming punch *B* and from there passes out through the vent in part *A*.

The fact that forming punch *B* has no draft at the end, while forming post *J* has a slight draft, and that there is less friction on the inside of the formed cup than there is on the outside, makes it possible for punch *B* to pick up the work. To make this action certain, however, springs *N* and *H* are provided. All working parts of the die are ground concentric, the sizes being determined by the thickness of the stock to be used. The dimensions mentioned in connection with the grinding of parts *B* and *J* are used for stock 0.025 inch in thickness. In forming stock of this thickness on the forming post *J*, which is 0.700 inch in diameter, a cup is produced which is 0.751 inch in diameter. Cups of this diameter proved very satisfactory with respect to the drive fit in the counterbored holes having a diameter of 0.749 inch. A punch and die of the design described worked satisfactorily on many classes of work with little or no expense for upkeep. An automatic feed for the stock can be applied if desired.

* * *

INFLUENCE OF HUMIDITY ON LEATHER

The strength and elasticity of leather are greater in moist air than in dry, and for that reason it is important in making comparative tests of leather to be sure that they are made under the same humidity conditions. A given piece of leather tested in a dry atmosphere might appear to be weaker than a much poorer piece of leather tested in moist air. Experiments have shown that an increase of from 35 to 55 per cent in relative humidity increases the strength of leather 13 per cent and the stretch 16 per cent. When the humidity was raised from 35 to 75 per cent, the average increase in strength was 42 per cent and in stretch 53 per cent. The Bureau of Chemistry of the United States Department of Agriculture has devised a room in which the humidity is under almost perfect control, so that tests of leather can be made that will be trustworthy. This testing room is claimed to be the only one in the world in which the humidity is so well controlled.

Hydraulic Bulging and Bending

Improved Method of Forming Shells by Hydraulic Pressure

IN the manufacture of many sheet-metal parts, operations such as bending, forming, and expanding can be performed economically by "hydraulic bulging." With the method to be described, the work is placed in a die, which is usually split, and water under a pressure varying from 600 to 1200 pounds per square inch is admitted from either a hydraulic accumulator or a force pump. A force pump is generally sufficient for the purpose, and gives a ready means of varying the fluid pressure; the initial cost is also low. In the case of hollow work, the water under pressure is admitted directly into the work itself, so that in this respect it differs from the older method of hydraulic bulging, in which the quantity of water is measured, put into the receptacle to be bulged, and the operation performed under a power press.

With the improved method, a power press is not required, and the construction of the dies is so simple that their first cost is much less than when the combined mechanical and hydraulic operation, commonly used in the past, is employed. Furthermore, the method of operation does not depend for its success upon the watchfulness of the operator in measuring the fluid. It is merely necessary to insert the work in the lower half of the dies, clamp the top half in position, admit the water under pressure from a suitable water cock and drain the water off after the piece has been formed. Another advantage of the process is the rapidity with which the water pressure forms the article to the desired shape, the time required being not more than one-sixth that taken by the other method.

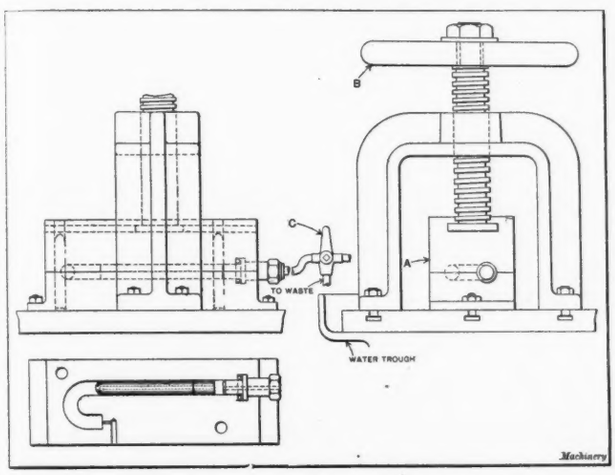


Fig. 1. Dies for making a U-shaped Bend, and Fixture in which the Dies are clamped while under Pressure

The finish produced by this bulging method is quite free from tool marks, and all bends are of full section throughout. An important point to be considered is the water pressure, which must be governed by the thickness of the metal and its physical characteristics. A safe pressure to use at first is about 700 pounds per square inch for annealed brass 0.020 inch thick, increasing this to approximately 1200 pounds per square inch for a thickness of 0.060 inch. If the pressure is excessive, it may burst the end of the shell, and so it is advisable to increase the pressure gradually until the desired results are obtained. An operation such as bending a tube requires more pressure than a simple expanding operation, since, in bending, the tube must be forced around a curved recess in the die. In an operation of this kind plenty of thin oil should be used to facilitate the movement of the work in this recess.

General Arrangement of the Dies

A typical arrangement of the dies used for bending is shown in Fig. 1. The lower die is fixed to a T-slotted table, and the upper half is clamped to it by means of a handwheel-operated screw passing through a bridge iron which is attached to the table. Instead of a handwheel for manual operation, it is entirely practicable to arrange a hydraulically operated plunger in the bridge as a clamp for the dies. In such an installation, a three-way cock may be employed first to admit pressure to the clamping plunger and then to admit the water to the dies and drain it from the dies.

Application to Thin Tube Bending

The shell shown at A, Fig. 2, is made into a gramophone swan-neck, and is drawn from a blank of sheet brass, 4.125

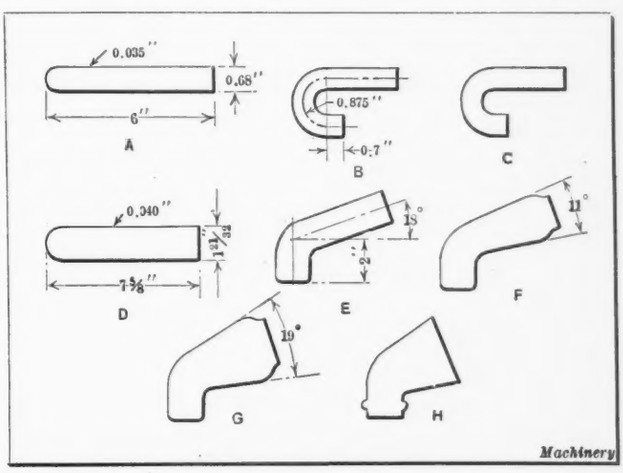


Fig. 2. Diagram showing Various Steps in the Production of Two Parts by Hydraulic Bending and Bulging

inches in diameter and 0.044 inch thick. This shell is bent as shown at *B*, by hydraulic pressure, in the die illustrated in Fig. 1. It will be noticed that the end of shell *A* is rounded; it is made this shape in the drawing operation, to facilitate the bending in the hydraulic dies and to give sufficient metal to permit a flat end to be formed subsequently.

From what has previously been said it will be understood that the dies are made in halves, the upper half *A* being clamped by means of the handwheel *B*, and a rigid support for the clamping screw is provided by the substantial bridge construction. The upper and lower members of the die are aligned by means of dowel-pins and during the operation they are opened just enough to permit the work to be placed in position. The plan view shows the position of the shell in the lower die prior to the bending operation. The water is admitted to the dies by means of a flexible connection to the pump or accumulator, and is controlled by the two-way cock *C*. A pressure of 1200 pounds per square inch is employed, and the water, when admitted, enters the shell and forces it around the bend, producing a shell with a square end and with a surface that is entirely free from wrinkles. In the end of the recess in the die is a channel leading to an air vent, which is an essential detail in the construction of dies of this type.

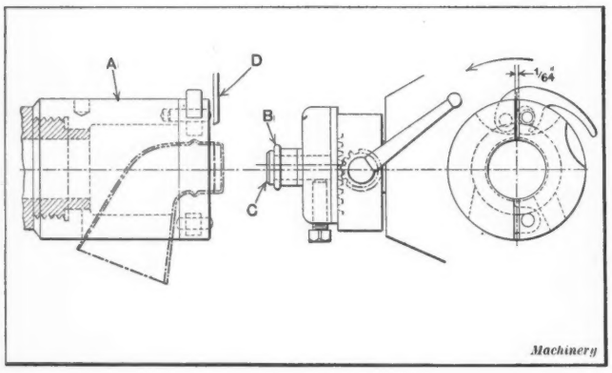


Fig. 3. Tool Equipment for forming a Bead by Spinning

After the operation has been completed the two-way cock is turned around to its second position, which shuts off the source of supply and permits the water in the shell to pass into the waste pipe. It should be mentioned that the contacting surfaces of the two die members are carefully lapped, and as a result, only a very slight line is produced at the parting. Lubrication of the shell and interior of the die is very important. This completes the bending of the shell, but there are a number of other operations required to make the swan-neck, which include cutting off the closed end, as shown at *C*, Fig. 2, squaring and tapping the long end, milling a slot in the long end, and punching a bayonet slot in the small end. As these operations do not pertain to hydraulic bending or bulging, they will not be described in the present article.

Bending and Bulging Operations

The manufacture of the swan-neck requires only a bending operation, but the making of a gramophone horn elbow (*H*, Fig. 2), is a good example of the possibilities of this method of metal-forming, since both hydraulic bending and bulging operations are employed. In this case, the diameter of the drawn shell *D* is somewhat larger than that of the swan-neck shell and the wall thickness is also greater. With this diameter and wall thickness it is doubtful whether uniformity of shape could be obtained by any other method of bending and expanding. The shell is drawn from a blank of brass, 6 5/16 inches in diameter and 0.050 inch thick, and five drawing and annealing operations are performed before the shell *D* is produced.

The drawing operations are performed in dies of familiar construction. The first bend *E* is performed hydraulically, the lower half of the bending die being shown in the upper part of Fig. 4. These dies are of similar construction to those used in the previous bending operation (Fig. 1), and the method of clamping and operation are essentially the same. A pressure of 1200 pounds per square inch is used to produce the bend. The shell is then annealed preparatory to expanding to the shape shown at *F*, Fig. 2. This operation is performed with the same type of bench fixture that is shown in Fig. 1, but the bulging dies are not of the same construction. Two bulging operations are performed, the second bulged shell being shown at *G*, Fig. 2.

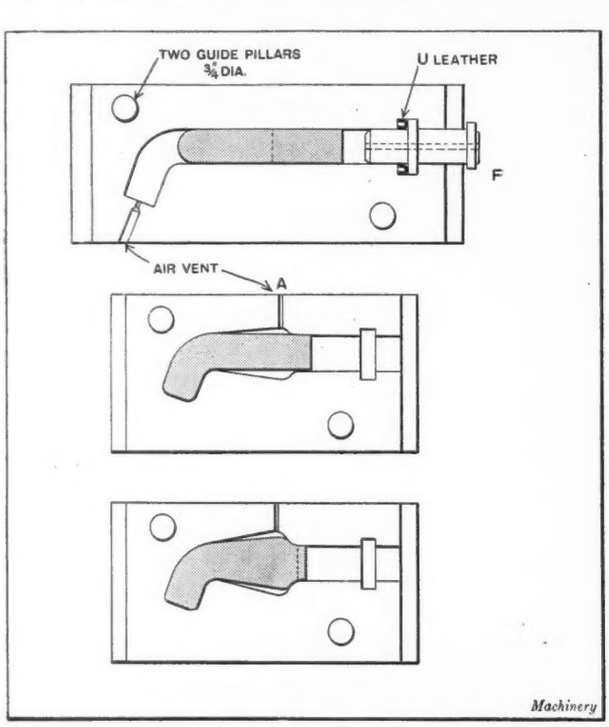


Fig 4. Dies used for bending and bulging a Gramophone Horn Elbow. Only the Lower Halves of the Dies are shown

The lower members of both sets of dies are shown in the lower part of Fig. 4. The second expanding operation, which is preceded by annealing, is necessary to finish the shell to the required shape. Both expanding dies are of the same type and it is necessary to provide a small air vent *A* at the bulged section. The bulged end of the tube is then trimmed to length, after which the small end is cut off and a bead spun on the stem. The appearance of the shell after the bead has been spun is shown at *H*, Fig. 2.

Although this beading operation is not performed hydraulically, the fixture used is of interest. The work is performed on a turret lathe. The body *A* of the fixture, Fig. 3, is fitted to the nose of the spindle and has a hinged clamp at the front end. The body has a large opening in the side through which the tube is put into position and clamped. In making this clamp, it is important to have the two halves nearly touch, leaving only a very small clearance to secure a firm grip on the work. Any distinct gap between the clamping members would result in a ridge being raised on the bead during the spinning operation. The spinning of the bead is effected by means of a roller *B* which revolves freely on stud *C* mounted in a rack-operated recessing tool-holder which is carried in the turret. The parting cutter *D*, which is mounted in the back toolpost, trims the work to length after the bead has been spun. The final operation in the manufacture of the shell is punching a bayonet slot in the small end.

Manufacture of Telephone Receivers

In manufacturing telephone receivers, the first step is drawing from a brass blank. After the necessary drawing operations, the shell has the general appearance shown at *A*, Fig. 5. This particular receiver is made from a blank 4½ inches in diameter and 0.072 inch thick. After the shell has been drawn and properly annealed, the open end is sized and the metal swaged to the proper thickness for

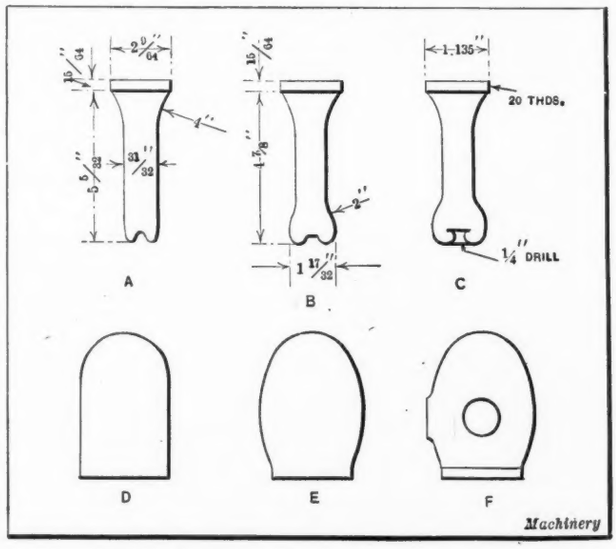


Fig. 5. Examples of Bulging as applied to a Telephone Receiver and an Automobile Side-lamp

subsequent threading. This operation is performed with the tools shown at the left in Fig. 7. The length, diameter, and shape of the shell are not materially changed by these dies.

Die *A* is formed with a flared mouth to suit the shape of the shell, and the large opening is finished to the diameter to which the work is to be sized. The die is held in position in the cast-iron bolster *C* by the ring *B*. The lower knock-out *D* ejects the shell at the completion of the operation. The pressure plunger *E* is controlled by spring *F* and holds the work in the die *A* while the punch *G* descends and fills the recess within the die opening.

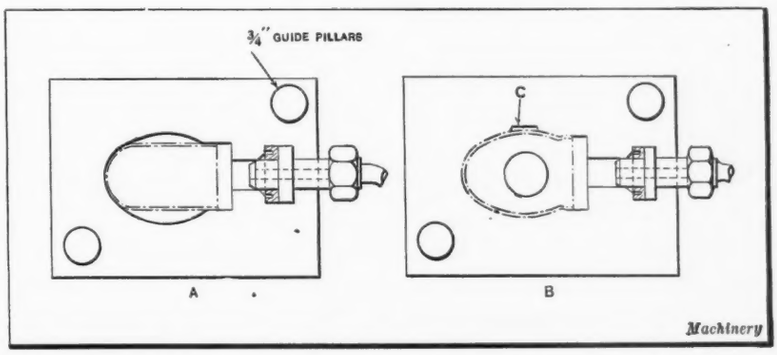


Fig. 6. Plan View of Dies used for bulging Automobile Side-lamp Shell and producing the Formed Bosses

It is necessary to design the dies so that pressure will be exerted on the flared part of the shell, since the action of the tools tends to force the shell downward through the die, which would distort it. The shallow grooves cut around the outside of plunger *E* insure a grip being maintained on this part of the shell. The swaging punch *G* is held in a recess in punch-holder *H*, and a knock-out on the press operates the ejector *J*. This member is a loose fit through the punch and has a stop-pin *K* to prevent it from falling through the punch. This ejector strips the work from the straight part *L* of the plunger, and it is shaped with a slot, so as to conform to the shape of the shell at the closed end and not deform it.

Bulging Operations on Receivers

Two methods may be employed for bulging the end of the shell, one of which utilizes a rubber pad as the expanding medium, and the other hydraulic pressure. Of the two, the hydraulic method is preferable, chiefly on account of the inexpensive tool construction, rapid operation, and low tool upkeep. By the hydraulic process a pressure of about 1200 pounds per square inch is required, using dies similar to those previously described.

The lower die member for bulging the telephone receiver is shown in Fig. 8. This illustration also shows the flexible connection, and the position of the work is indicated by a heavy broken outline. These dies are operated under the bench-type bridge iron fixture illustrated in Fig. 1, and with few exceptions the dies contain no special features. Pin *A* is required to support the indent in the end of the shell and prevent it from losing its shape under pressure. In the working position the flanged sector on this pin is located in a groove in the bottom half of the die, thereby resisting end thrust. When the dies are open, the pin is turned through 180 degrees to bring the flanged piece clear of the groove in the die. Then the pin can be withdrawn, permitting the bulged shell to be removed.

Using Rubber Instead of Water for Bulging

Another method of forming the bulged end is by the use of rubber as the expanding medium. A double-action power press is also used when the bulging operation is performed by using a rubber pad in place of fluid pressure, and the dies required are illustrated at the right in Fig. 7. The lower die member is composed of two parts *A*, which are confined within the body *D* of the die and which are

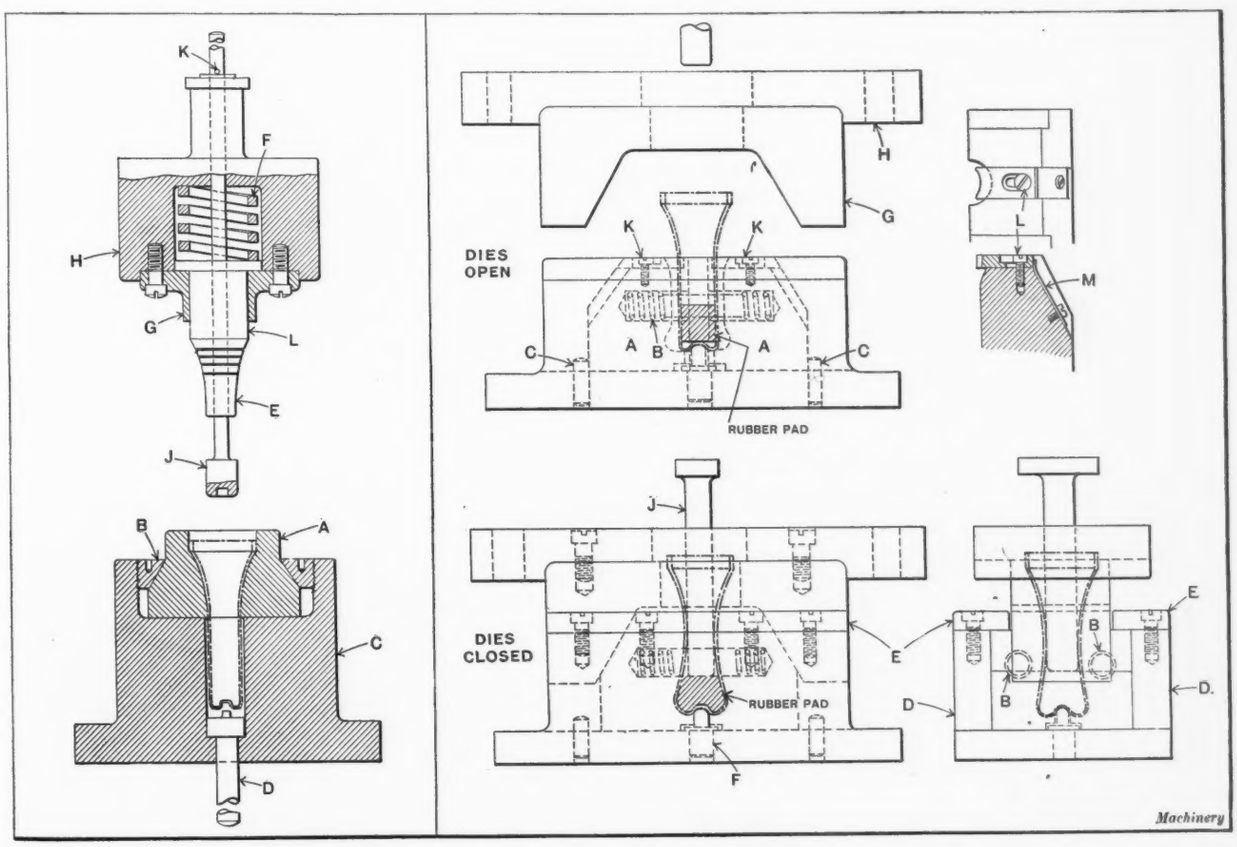


Fig. 7. (Left) Dies used for swaging the End of a Telephone Receiver prior to threading. (Right) Dies used for Bulging Operation performed by the Use of a Rubber Pad instead of hydraulically

normally held apart by the action of springs *B*. The outward movement of the die members *A* is limited by pins *C* which are so located that the die will just permit the work to be extracted after being bulged. Cover plates *E* prevent the lower dies from lifting from the body *D*. Peg *F* is provided for locating purposes, and is fixed in the body of the tool so that it engages the indentation in the end of the shell to locate it and keep it from losing its shape.

The sides of the dies *A* are tapered, so that the corresponding taper on the die-closing block *G* operates against the lower dies and closes them against the tension of springs *B*. The closing block is carried in the top tool-holder *H*, and the punch *J* operates through both these members, extending into the shell and expanding the pad of rubber previously placed in the end of the shell. In addition to peg *F*, two side spring plungers *K* are employed to locate the shell in the open dies. These plungers are shaped to fit the curvature of the work and prevent side tilting. They operate in a groove on the top of dies *A*, and are retained by screws *L*, and operated against the pressure of flat springs *M* attached to the sides of the dies (see partial sectional view).

It is not necessary to use an exact quantity of rubber for the bulging operation, since the ram adjustment of the press will enable the operator to accommodate different sized pieces of rubber after he has noted the amount of

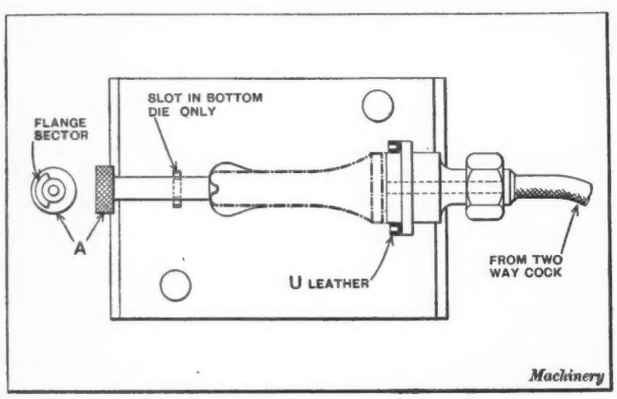


Fig. 8. Plan View showing One Section of Bulging Die used when Bulging of Receiver is performed hydraulically

pressure required to complete the bulge. One piece of rubber may be used for as many as one or two thousand operations.

The bulged shell, partially dimensioned, is shown at *B*, Fig. 5, and the completed shell is shown at *C*. After bulging, the operations consist of drilling a ¼-inch hole in the formed end, spinning the flanges produced by this operation, tinning, vulcanizing, polishing, threading, and facing. The purpose of spinning the flanges produced by drilling the hole is to prevent fraying of the telephone cord which passes through this hole.

Bulging Automobile Side-lamp Shells

The drawn shell *D*, Fig. 5, is made from 0.025-inch thick sheet brass, and two bulging operations are required to produce the shapes *E* and *F*, the latter being the approximate shape of a completed automobile side-lamp. After the necessary annealing and trimming operations, the die shown at *A* in Fig. 6 is used to produce shell *E* by direct hydraulic pressure. These dies are made in halves and are operated on a bench fixture of the type illustrated in Fig. 1. A water pressure of 800 pounds per square inch is employed, which may be furnished either by a hydraulic accumulator or a force pump. It is important to note that an annealing operation was necessary before this bulging operation, since otherwise the hard shell produced in drawing would cause the work to be split under the strain of bulging.

It is not practicable to perform the next forming operation hydraulically. This operation consists of expanding the mouth of the shell, and if it were attempted to accomplish this by water pressure a space would have to be left around the shell for the water to force the metal into. The result would be that water would be admitted to both sides of the shell, and no expanding action would result. With this method of hydraulic forming the water must be confined to the interior and not be allowed to fill spaces that are intended for the forming operation. The operation of expanding the mouth of this shell is performed on a power press, with split dies arranged to hinge and clamp by means of a cam.

The final forming operation, in which the two bosses on the lamp case are produced, is a typical example of the sort of work that can be performed by hydraulic bulging without difficulty and without a great expenditure for tools. The tools for this operation, shown at *B* in Fig. 6, consist of a top and bottom die, properly formed to receive the shell and containing recesses to produce the bosses. One boss recess is let into the bottom half of the die and the other *C* is partly in each die member. The same construction of dowel-pins for aligning the die members, flexible connections, and two-way cock are used as employed in other bulging and forming operations previously described. The pressure employed in this operation is 800 pounds per square inch.

The steps required to complete the lamp shell are two piercing operations in the bosses, rough-polishing the outside of the shell, soldering a bushing and a spigot into the holes, enameling the inside of the shell, assembling glass in position and spinning over the open end, and finish-polishing the outside.

* * *

DETERMINING THE LENGTH OF ROLLED BELTS

By W. F. SCHAPHORST

A rule for determining the length of a rolled-up belt was given on page 144 of October MACHINERY. The method given in the following, which was recently developed by the writer, is somewhat simpler and quicker than the one mentioned. By means of a yardstick or rule, measure the distance $(t + d)$ which amounts to the total thickness of the ring of belting material plus the diameter of the hole. Taking the measurement $(t + d)$ in inches, multiply it by 0.2618, and multiply the product thus obtained by the number of complete turns in the roll. The result is the length L of the belt in feet. Expressed as a formula,

$$L = 0.2618\ (t + d)\ N$$

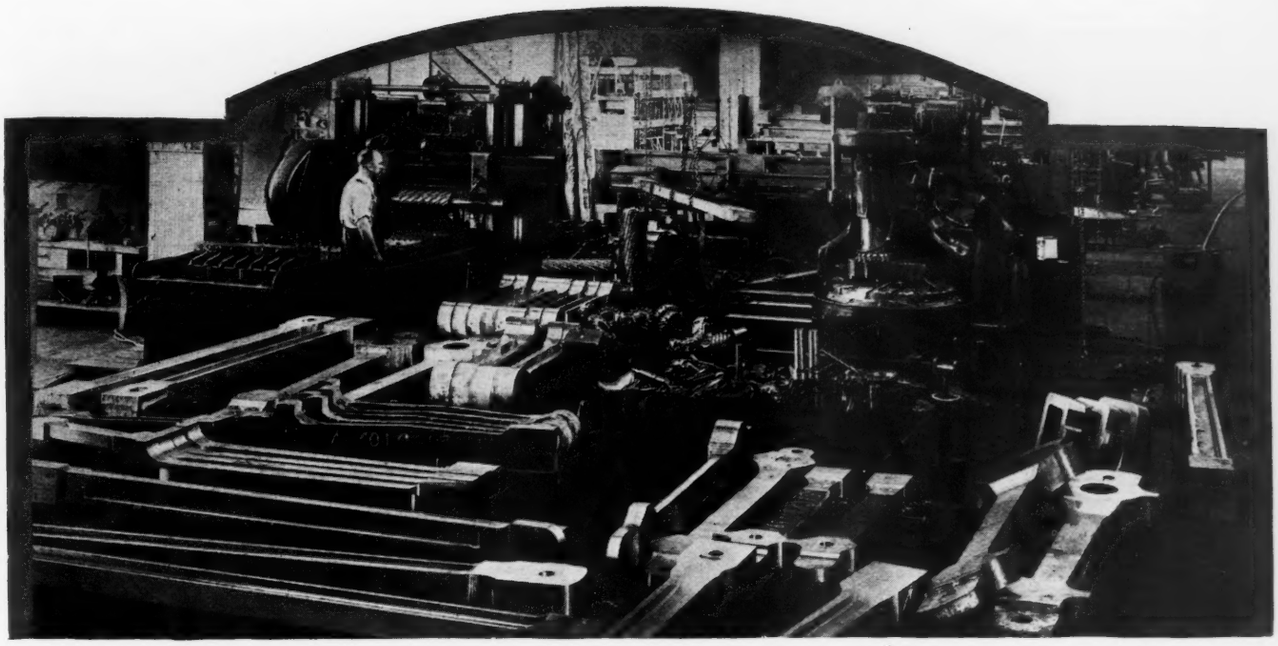
where t = total thickness, in inches, of ring of belting;
d = diameter, in inches, of opening or hole; and
N = number of complete turns.

The measurement $(t + d)$ can often be taken without removing the roll of belting from its place in the stock-room. It will be noted that the method here given requires only one measurement, whereas the rule given in October MACHINERY necessitates the making of two measurements.

* * *

CRACKING OF ENAMELED WARE

The Bureau of Standards has recently conducted tests to find the cause of the cracking of enamel on enameled ware, and has found that it occurs when the enamel is not suitable for the metal that it covers. Some enamels have the same rate of expansion as the metal that they cover, and when utensils are covered with these enamels, there will be no cracking; but when the enamel has one rate of expansion and the metal another, cracks will appear in heating or cooling. The rate of expansion of the enamel, depends upon its composition, and can be adjusted quite accurately to fit that of the metal. The Bureau of Standards has collected a great deal of information on this subject, and expects shortly to publish a bulletin giving compositions of enamels that can be used to the best advantage.



Milling Locomotive Side-rods

Results of Tests made to Determine the Possibilities of Reducing Costs in Railroad Shops by Milling

IN October MACHINERY, a description was published dealing with tests conducted at the plant of the Ingersoll Milling Machine Co., Rockford, Ill., to determine the possibilities of heavy-duty milling machines of special design for handling locomotive machine shop work. Machining data for main rods and main rod straps were given, showing the actual results obtained when working under favorable conditions. The present article describes the milling of side-rods with the same types of machines and equipment employed for milling the main rods and straps. The speeds, feeds, cutter sizes, dimensions of cut, horsepower and time are given in each case, and this information is also presented in tabular form for convenient reference.

The main side-rods are made of chrome-vanadium steel, and are heat-treated, the same as the main rods and main rod straps mentioned in the previous article. The first milling operation, which is slabbing, is illustrated in Fig. 1. In this operation, standard Ingersoll adjustable fixtures and inserted-tooth helical type high-speed milling cutters were used. Two forgings were slabbed at a time. The cutters were 9 inches in diameter, 24 inches long, and operated at a cutting speed of 33 feet per minute and a feed of 3 inches per minute. The low cutting speed and feed used in this slabbing operation were necessary because of the hard scale on the surfaces of the forgings, and were not the result of cutter inefficiency, as will be noted in later operations in which the speeds were materially increased. The depth of cut was 23/64 inch, the total width of cut 30⅝ inches, and the machining time, 4 hours and 33 minutes for both sides of two rods.

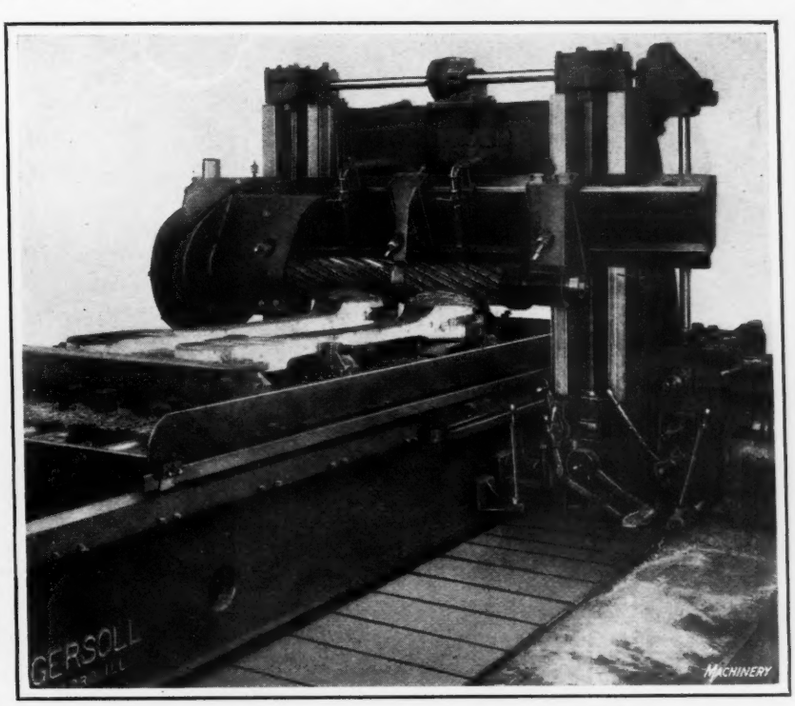


Fig. 1. Slabbing the Sides of a Locomotive Main Side-rod

The second operation was that of milling the edges of the rods. For performing this work, a horizontal type machine was used. Four forgings were edged at one time, although the machine table had accommodation for six forgings. The working conditions under which the edging cuts were taken were the same as in the slabbing operation, that is, the hard scale limited the cutter speed and feed to those used for slabbing. The same size and type of cutter was also used for edging, but the depth of cut was ⅞ inch, and the width on the straight part of the rods 8 inches. The two cutters removed a total of 21.1 cubic inches of metal per minute at an expenditure of 1.2 horsepower per cubic inch. The time required to mill both edges of four rods was 3 hours and 32 minutes, including the time for setting up.

The third milling operation was that of contour-milling both ends of the rods; the

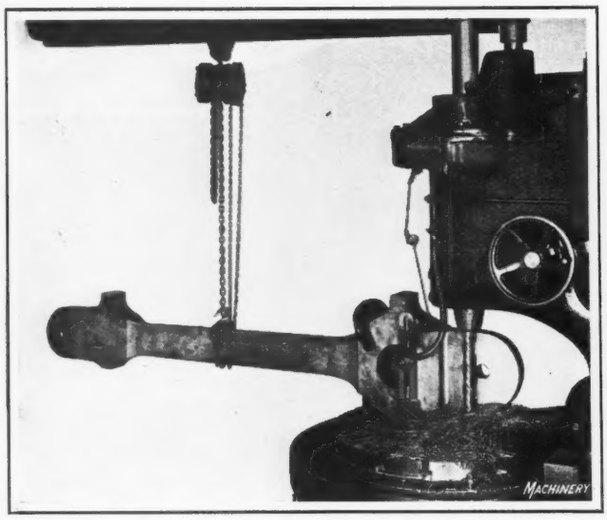


Fig. 2. Milling the Tongue of a Main Side-rod

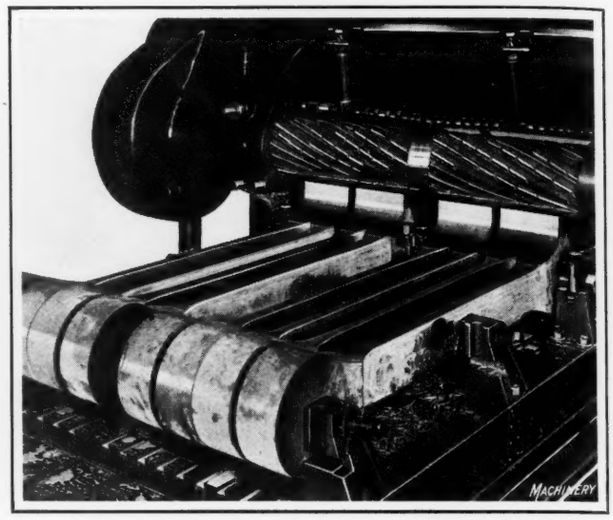


Fig. 3. Edging Eight Intermediate Side-rods

set-up for this operation was similar to that illustrated in Fig. 4. In milling the contours, a helical inserted-tooth cutter was used, 5 inches in diameter and 12 inches long, and a combination of hand and power table feed was employed. The cutter speed was 35 feet per minute, the width of cut 11½ inches, and the depth of cut varied from ½ to 1 inch with the contour of the work. The floor-to-floor time required to mill both ends of two rods was 5 hours.

The last operation on the main side-rods is illustrated in Fig. 2, which shows a vertical rotary machine equipped with a 2⅜-inch solid helical milling cutter. The work consisted of milling both sides of the tongue on each end of the rods, with the extending end of the forging supported by a hoist. The tongue was clamped to an angle-plate in a vertical position. The table feed was 2½ inches per minute, the cutter speed 65 feet per minute, the depth of cut varied from ⅛ inch on face of tongue to 1⅜ inches at radius, and the width of cut was 11½ inches. The milling time was 1 hour and 10 minutes for four surfaces.

Four milling operations were performed in machining the intermediate side-rods, the first of which consisted of slabbing both sides of the rod. As this operation was similar to the slabbing operation illustrated in Fig. 1, a set-up of this job is not shown. Two rods were slabbed at a time on a horizontal machine, with two helical inserted-tooth Ingersoll cutters, 9 inches in diameter and 24 inches long. The table feed was 2 5/16 inches per minute, the speed of cutter 33 feet per minute, the depth of cut 11/32 inch, and the total width of cut 30½ inches. The floor-to-floor time required to slab both sides of two rods was 4 hours and 8 minutes.

The edging operation is illustrated in Fig. 3 from which it will be seen that eight rods were milled at a time. The cutters and cutter speeds for this operation were the same as for slabbing. It will be noted that in this case also the speed was limited by the hard scale on the forging. For edging, a table feed of 3 inches per minute was used, as compared with 2 5/16 inches for slabbing. The depth of cut was ½ inch, total width of cut 10½ inches, amount of metal removed per minute, 15.6 cubic inches, horsepower per cubic inch of metal removed, 1.81, and the time, 1 hour and 56 minutes for eight rods.

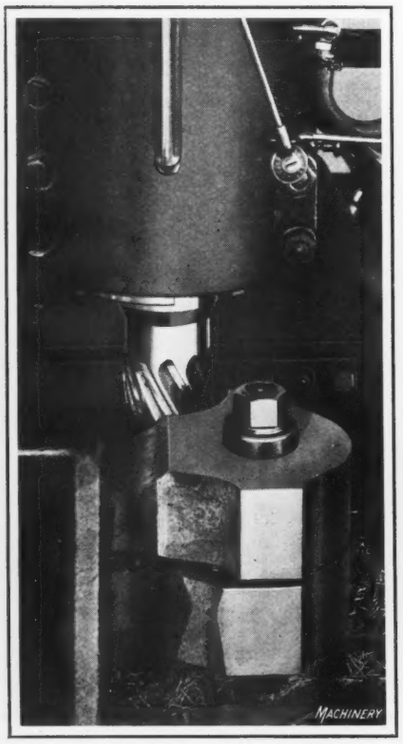


Fig. 4. Milling Contours at Ends of Rods

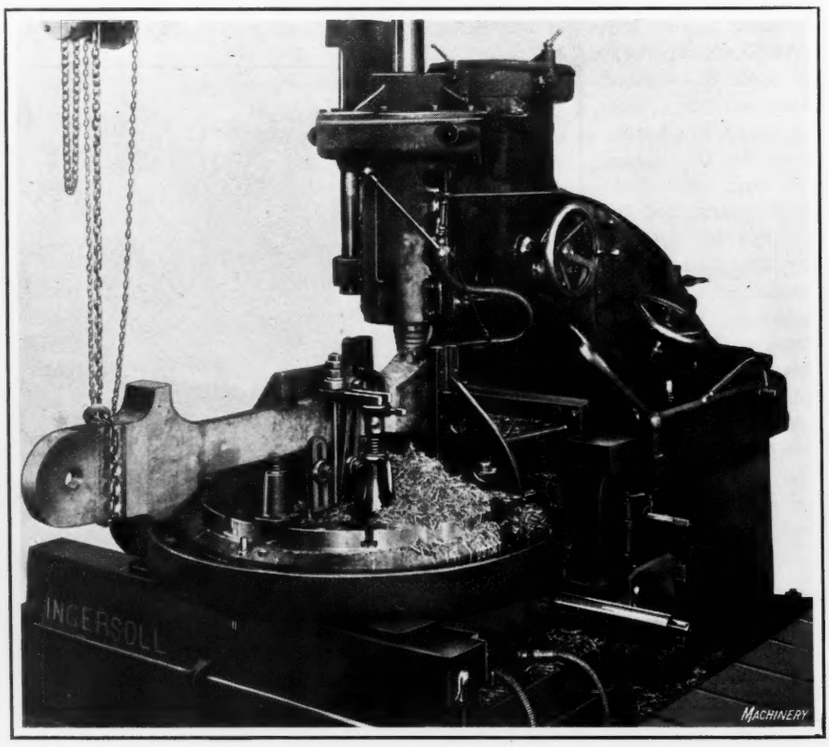


Fig. 5. Machining a Tongue Slot in an Intermediate Side-rod

The third operation performed on the intermediate rods was milling the contour at both ends of the forgings. This operation is illustrated in Fig. 4. The cutter used was of the helical inserted-blade type, 5 inches in diameter and 12 inches long. Both hand and power feeds were used, the cutter speeds being 35 feet per minute. The depth of cut was from ⅜ to ½ inch, the width of cut 8½ inches, and the floor-to-floor time for both ends of two rods 4 hours.

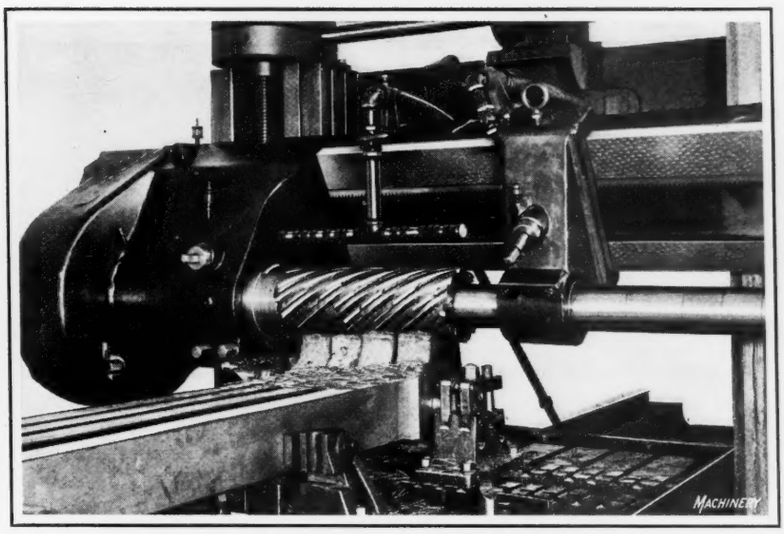


Fig. 6. Beginning of Edge-milling Operation on Locomotive Front Side-rods

The final operation consisted of milling a slot for the main side-rod tongue, the set-up for which is shown in Fig. 5. A solid helical cutter, 2¼ inches in diameter was used, and after the full length of the slot had been milled the cutter was fed out, taking a finishing cut on one side of the slot. It was then fed in again, finishing the other side of the slot. For the roughing cut on the solid forging, a table feed of ⅜ inch per minute was used, and for the two finishing cuts the rate of feed was 1½ inches per minute. The cutter speed was 50 feet per minute, depth of slot 11⅝ inches, width of tongue 10¼ inches, width of slot 2¼ inches, and floor-to-floor time 1 hour and 20 minutes per rod.

Milling Front Side-rods

The set-up for the first milling operation on the front side-rods, that of slabbing, was similar to the slabbing operation illustrated in Fig. 1, the type of machine and the style and size of cutter being identical. These rods, instead of being made of heat-treated chrome-vanadium alloy steel, are carbon steel forgings. The rate of table feed employed was 5⅛ inches per minute, and the cutter speed 52 feet per minute. A cut ½ inch deep and 13 9/16 inches wide was taken by each of the two cutters on the sides of each rod, removing a total of 61.5 cubic inches of metal per minute. The power consumption was 1.35 horsepower per cubic inch of metal removed, and the floor-to-floor time was 4 hours and 25 minutes for slabbing the four surfaces.

The second operation, illustrated in Fig. 6, consisted of edging the rods. Although the machine illustrated is shown equipped for handling only four rods at a time, if its full capacity is taken advantage of, eight rods can be machined at a time. A 9- by 24-inch helical inserted-tooth milling cutter was used in this operation, with a table feed of 8⅞ inches, and a cutter speed of 52 feet per minute. With this rate of feed the finish was somewhat irregular, and tool marks 0.003 inch deep appeared at intervals of about ⅜ inch. However, men familiar with locomotive work who inspected these surfaces were of the opinion that this finish would be acceptable and that a high table feed would be preferable to a slower feed, even though the finish were not as smooth. The depth of cut was 13/32 inch, the width 16 inches, the amount of metal removed per minute 43.5 cubic inches, and the horsepower consumed per cubic inch of metal removed 1.005. The floor-to-floor time required to mill both edges of four rods was 4 hours and 5 minutes.

The third and last milling operation on the front side-rods consisted of channeling the forgings on both sides. This operation is not illustrated, but the set-up was similar to that shown in Fig. 3 of the article "Milling Locomotive Main Rods," in October MACHINERY. Two 3¼- by 10-inch diameter staggered inserted-tooth cutters were used, at a speed of 58 feet per minute. The rate of table feed was 5⅝ inches per minute, depth of cut 1 9/16 inches, width of cut 3 9/32 inches, amount of metal removed per minute, 57.7 cubic inches. The power consumption per cubic inch of metal removed was 1.13 horsepower, and the time required for channeling both sides of two rods, floor to floor, was 2 hours and 25 minutes.

The data presented in this article represents the actual results obtained. It was the first time that these operations had been performed with the equipment used, and if they were repeated in the regular process of manufacturing, it is probable that even better results could be obtained.

MILLING LOCOMOTIVE SIDE-RODS

	Operation No.	Operation	Table Feed, Inches per Min.	Cutter Speed, Feet per Min.	Depth of Cut, Inches	Total Width of Cut, Inches	Total Cu. In. Metal Removed per Min.	Horsepower per Cubic Inch	Production Time, Floor to Floor
Main Side-rods, Alloy Steel, Heat-treated	1	Slabbing (both sides)	3	33	23/64	30⅝	....	....	4 hr. 33 min. (2 forgings)
	2	Edging (both edges)	3	33	⅞	8 (in center)	21.1	1.2	3 hr. 32 min. (4 forgings)
	3	Mill contours (both ends)	Hand and power	35	½ to 1	11½	....	....	5 hours (2 forgings)
	4	Mill tongues (both sides)	2½	65	⅛ to 1⅜	11½	....	....	1 hr. 10 min. (4 surfaces)
Intermediate Side-rods, Alloy Steel, Heat-treated	1	Slabbing (both sides)	2 5/16	33	11/32	30½	....	....	4 hr. 8 min. (2 forgings)
	2	Edging (both edges)	3	33	½	10½	15.6	1.81	1 hr. 56 min. (8 forgings)
	3	Mill contours (both ends)	Hand and power	35	⅜ to ½	8½	....	....	4 hours (2 forgings)
	4	Mill slot	⅜ (rough) 1½ (finish)	50	11⅝ (slot in solid)	2¼	....	....	1 hr. 20 min.
Front Side-rods, Carbon Steel	1	Slabbing (both sides)	5⅛	52	½	27⅛	61.5	1.35	4 hr. 25 min. (2 forgings)
	2	Edging (both edges)	8⅞	52	13/32	16	43.5	1.005	4 hr. 5 min. (4 forgings)
	3	Channeling (both sides)	5⅝	58	1 9/16	3 9/32	57.7	1.13	2 hr. 25 min. (2 forgings)

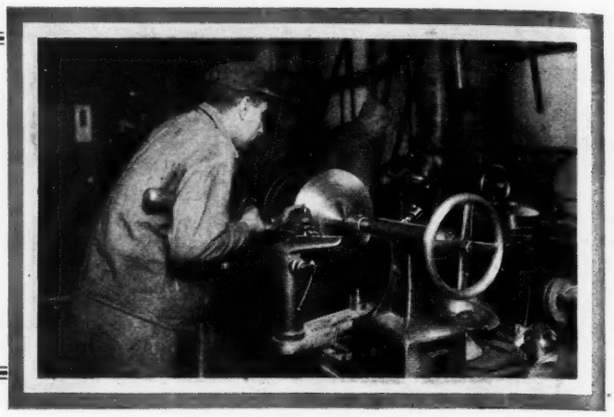
Machinery

* * *

The Chamber of Commerce of the United States has collected figures that indicate that $70,000,000 is spent annually by American industries on research work. About one-half of this sum is spent in laboratory research, while the remainder is expended in experimental and development work.

Spinning Chucks

By D. C. OVIATT
D. C. Oviatt & Co., Cleveland, Ohio



SPINNING chucks, which are used extensively in the manufacture of coffee pots, kettles, and numerous other utensils of similar shape, are frequently constructed in sections, held together by a ring or other suitable means so that the chuck may readily be disassembled and removed from the utensil after the spinning operation has been completed. Spinning chucks of a different type, embodying some interesting mechanical features, are illustrated in this article. These chucks are not of the sectional type, but are so designed that they should be applicable to a wide range of spinning work.

The spinning chucks shown in Fig. 1 are used in the first two spinning operations required in shaping a water pitcher. The design of both chucks is essentially the same. The reduction in the diameter of the work is indicated by the outline of the work before and after each operation, as shown at *A* and *B*, respectively. The work is first located in the driving chuck, in which it is held by end thrust, by the following arrangement: There is a driving plate *C* of a diameter to suit that of the inside of the shell, which contains a female center by means of which the spinning chuck is aligned before the operation is started. This driving plate is split through the center, and is hinged so that it can be removed from the shell without difficulty. The center shaft *D* is supported at its outer end in the tailstock, in which it is free to revolve, so that when the tailstock is slid along the ways of the lathe in the direction of the headstock, the opposite end of the device will be centered in the female center of plate *C* and secured in this position by clamping the tailstock to the lathe bed.

The opposite end of shaft *D* carries a ball thrust center *E*, which is free to slide on the shaft, so that after the spinning chuck has been centered, it may be offset sufficiently to bring the spool *F* against the inner wall of the shell, as shown in the illustration. The spool is keyed to the shaft so that it revolves with it, and thus drives the shell, and, through friction, the spinning roll, by means of which the pressure that shapes the work is applied.

The position of this roll is indicated in the illustration; it is carried in a holder, which during the spinning operation, is supported by a tool-rest. A spring collar *G* telescopes over the spool and bears against the end of the shell to support it during the application of the pressure required to form the metal. As the shell is spun out, the increasing length forces the collar *G* back, compressing the spring back of it, so that the longer the shell becomes and the greater the amount of overhang produced, the greater will be the tension exerted to support it.

After the shell has been spun down to the contour of the spool and the operation is completed, the spinning chuck and work can be readily removed by simply moving the tailstock transversely until the tool is in alignment with the lathe spindle, in which position the tool can be easily withdrawn from the shell. Driving plate *C* is then folded over on its hinges and also withdrawn, which leaves the shell free to be removed. The second-operation chuck, shown in the lower part of the illustration, continues the reduction process by the use of a suitably designed spool.

Another spinning chuck which closely resembles those just described is shown in the upper part of Fig. 3. This chuck is not provided with a ball thrust center, but in other respects is the same as the other types. The design of spinning chuck shown in the lower left-hand corner of this illustration is used for forming the top of kettles, and the

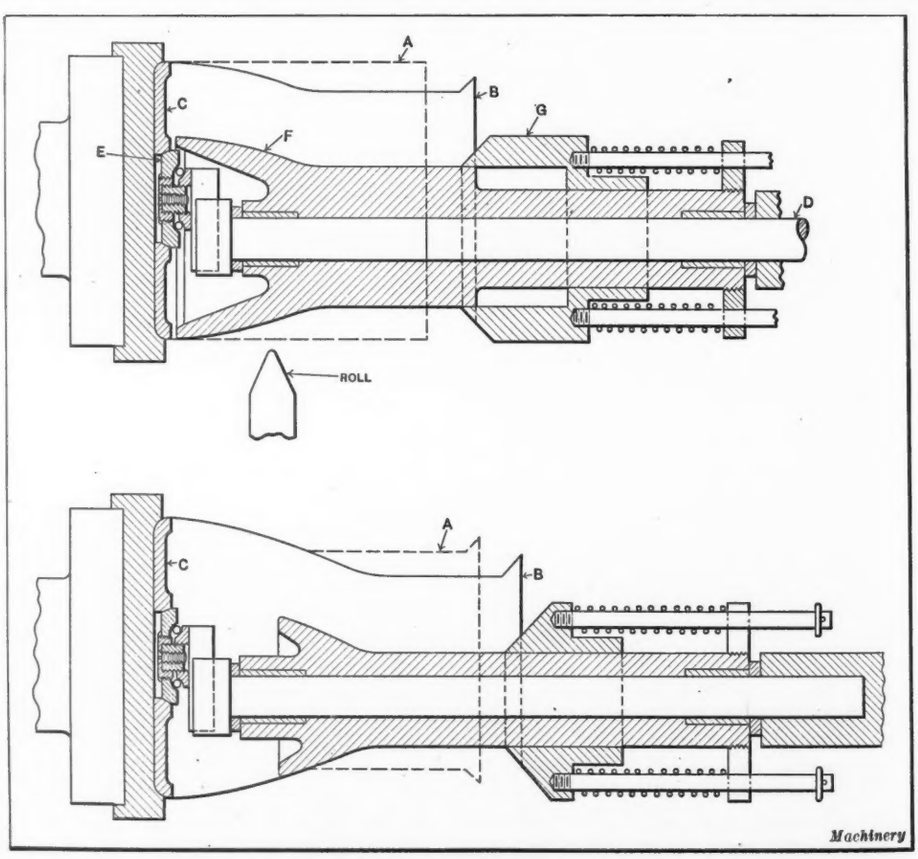


Fig. 1. Spinning Chucks used in the Manufacture of Water Pitchers

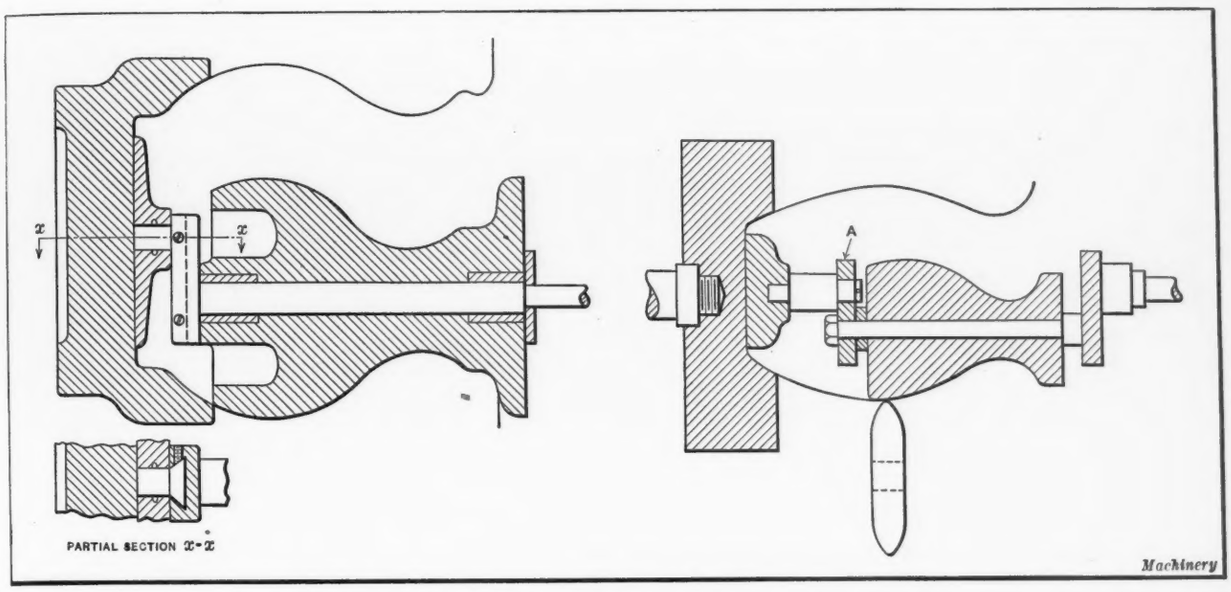


Fig. 2. Additional Examples of Chucks used in spinning Sheet-metal Utensils

spool employed is designed simply to form the curl at the top. The driving plate in this case is not required to be hinged, since the top of the kettle is large enough to permit the use of a driving plate that can be withdrawn directly from the shell without folding it. The shell is held by end thrust, and the center stud on which the tongue *A* is carried has sufficient axial play so that the shell and driving plate can revolve and the shaft that carries the spool be held stationary in the tailstock. Slide *B* and tongue *A* are dovetailed, and the slide provided with a taper gib to compensate for wear. The fact that the shell does not overhang excessively enables it to be held without much thrust, leaving the driving plate free to revolve against the friction produced by the contact of tongue *A*.

The spinning chuck shown in the lower right-hand corner of Fig. 3 is used for spinning such shells as bulged kettles. The work is located in the driving chuck, and held by a driving plate, carried on the end of a revolving tail-center *C*. The tail-center is secured in the tailstock by a set-screw. A forming roll *D* is held between adjustable centers in a suitable yoke, attached to the saddle of the lathe. The forming roll may be made of wood and provided with metal centers, and should of course, be adjusted to revolve freely with the work. The bulging roll *E* is carried on a holder *F*, and is mounted on ball bearings. The holder is attached to the compound slide of the lathe, so that the operating handle of the compound slide can be employed to swing the bulging roll outward as the kettle is being spun to the contour of the forming roll.

Other designs of spinning chucks are illustrated in Fig. 2. That shown at the left is similar in construction to the one shown in the lower left-hand corner of Fig. 3. In this design, however, a spool of rather special shape is required, because of the shape of the coffee pot that is spun by the use of this chuck. The dovetail slide construction employed in the chuck shown in the lower left-hand corner of Fig. 3, is also used in this chuck, as indicated by the partial sectional view below the chuck, Fig. 2. It will be noted that the bulbous end of this spinning spool has been lightened considerably by recessing it. The top of the coffee pot is large enough to permit the driving chuck and spool to be withdrawn without special provision being made for this in the design.

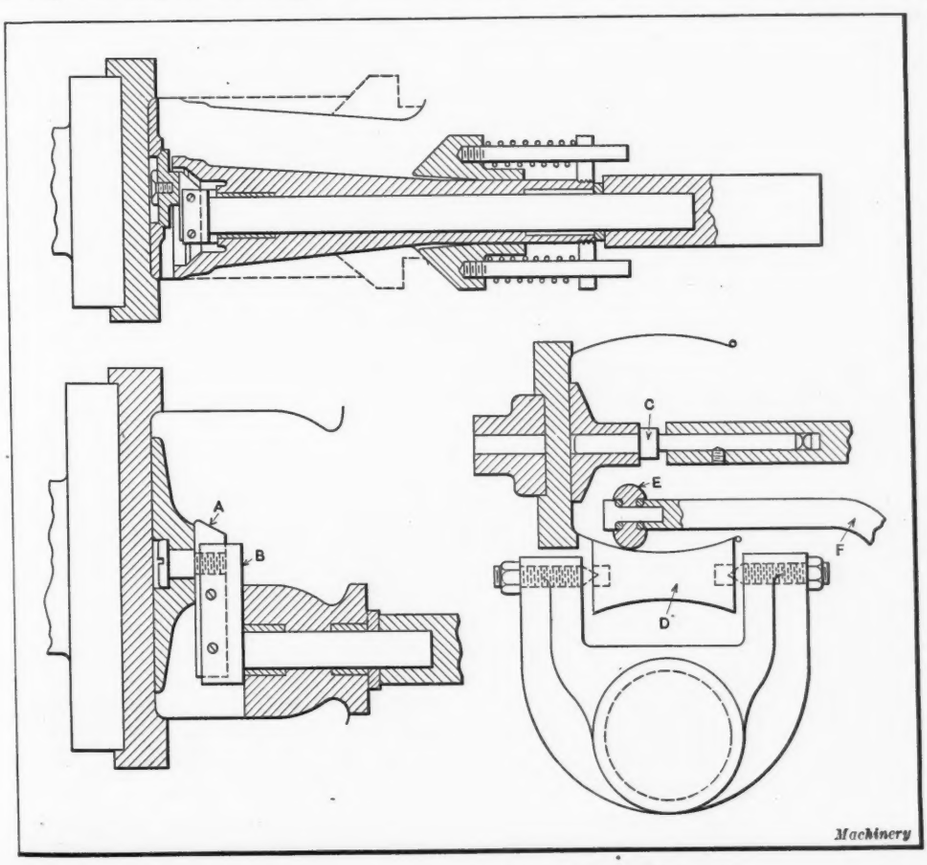


Fig. 3. Spinning Chucks for Kettles and Various Bulged Shells

In the right-hand view of this illustration is shown a type of spinning chuck that does not employ either the ball thrust center or the dovetail slide construction for transverse adjustment. The supporting arm *A* is carried on a shouldered center stud, to which it is secured by a cotter-pin. This chuck is used for spinning pots which may be considered as special for this particular size of shell, there

being no radial adjustment provided.

The spinning chuck illustrated in Fig. 4 is radically different from those previously referred to. This chuck is for wiring or beading the top of certain shells. The use of this tool is generally preceded by a spinning operation in which the top of the shell is spun outward to concave it, so that in the wiring operation the top edge of the metal may be readily picked up by the roll shown at *B* and then wired by means of the wiring roll *C*. Shells of this kind are seated in a suitable chuck, and supported at the open end by a tapered plug *D*, which is carried on a center stud. The center stud is free to revolve in the tail-spindle, and is provided with a collar for confining an extension spring that provides the axial thrust for supporting and driving the shell. The tapered plug revolves, of course, with the center stud, and is traversed axially by means of the coil spring, to compensate for the increase in opening produced by wiring up the end of the shell. To permit this tapered plug to be driven as well as moved axially, it is fitted to the center support by a sliding key (not shown).

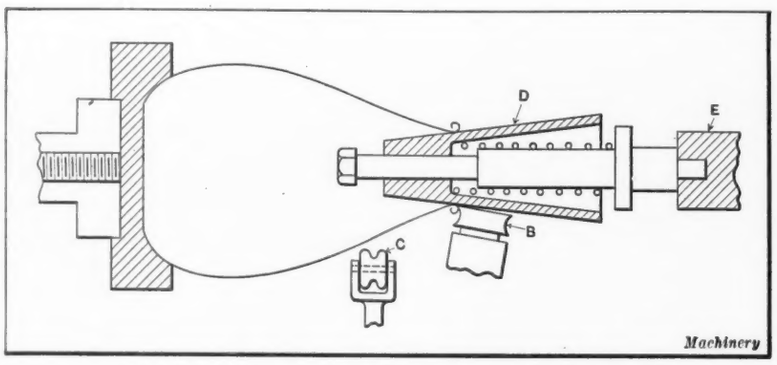


Fig. 4. Spinning Chuck for wiring or beading the Top of Shells

Both the picking up roll *B* and the wiring roll *C* are carried by a specially designed bracket attached to the compound rest of the lathe, so that after the roll *B* has been swung into the position illustrated and the metal has started to curl, the cross-slide can be adjusted over and in, to bring the wiring roll into engagement with the work. These rolls may be mounted in any appropriate way; the design shown employs a yoke and trunnion for the wiring roll and a plain shouldered bearing for the picking up roll. The bracket that supports these two rolls may require the use of link levers or other suitable means for swinging one roll out of the way while the other is at work, if the design of the shell should make this necessary.

* * *

DIE FOR PUNCHING ODD-SHAPED HOLE

By M. E. DUGGAN

It is a simple matter for the toolmaker to produce a punch and die for piercing round holes in sheet metal, as no special tools are required. It is a more difficult problem, however, to produce a punch and die for holes other than round—as for instance, the hole in an electric bell such as shown at *A* in Fig. 1. The making of punches and dies for work of this nature usually requires the use of special tools.

The punch used to pierce the hole in bell *A* is shown at *B*, and the die is shown at *C*. One of the nine broaches made especially to produce the hole in die *C* is shown at *D*. Each of these broaches has nine teeth in the ¾ inch of its cutting length. Each broach takes a cut about 0.0010 inch deep, the width of cut taken by the finishing teeth of the last broach used being 0.0300 inch. The broaches are numbered from 1 to 9, each broach having its number stamped on the shank end. This provides a means of identifying the different sizes so that they may be used in the proper consecutive order.

The milling of the punch *B* is described in the following: The shank end of the punch, after being turned to the required dimensions, is placed in the hole *E* of the special holder shown in Fig. 2. The tailstock center on the milling machine is then inserted in the center in the blank punch. The supporting screw *F* in the arm *G* is brought up against the work to prevent chattering or bending of the punch during the milling operation. The relative positions of hole *E* in the special work-holding bushing and the milling cutter *H* are shown in Fig. 2. The supporting arm *G*, however, is shown under instead of at the side of the bushing. In operation, this arm is positioned so that set-screw *F* will support the work against the thrust of the milling cutter, as previously mentioned. A plug for testing the concentricity of the holder with respect to the milling machine spindle is shown at *K*.

A special tool for backing off the teeth of the milling cutter is shown at *L*. This is a regular "double center" tool designed to be operated by hand in the manner commonly referred to as "pumping." One side of the punch is milled off at the first cut, after which the index-head is given a half revolution, and a cut taken on the opposite side of the punch. The finished broaches, punches, and dies were hardened in the usual way.

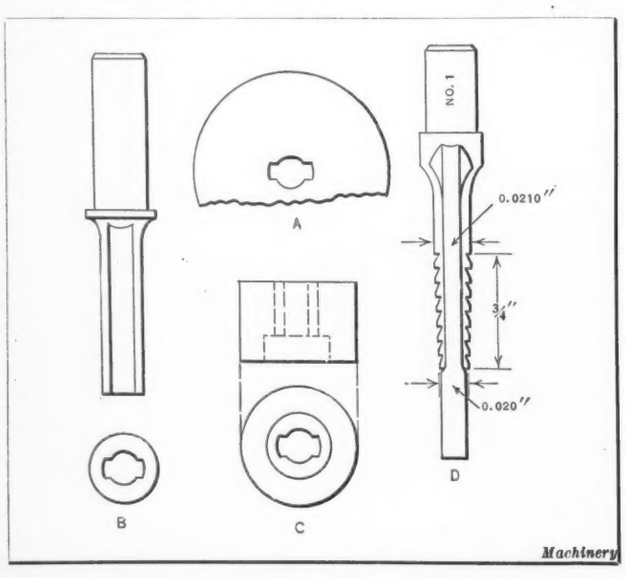


Fig. 1. Punch and Die and Broach used in making Die

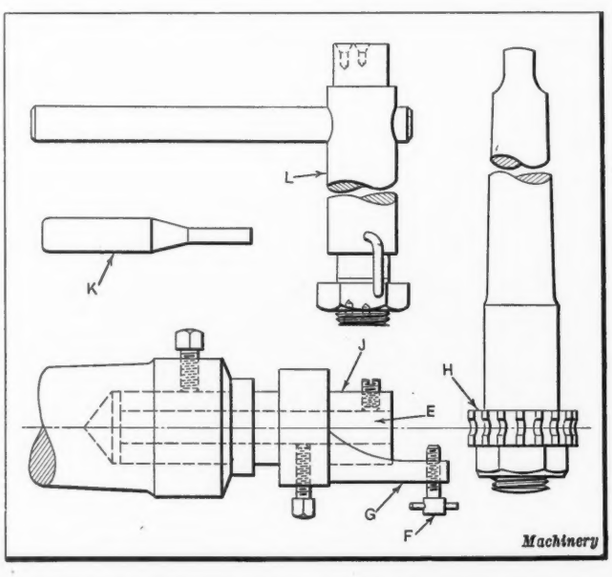
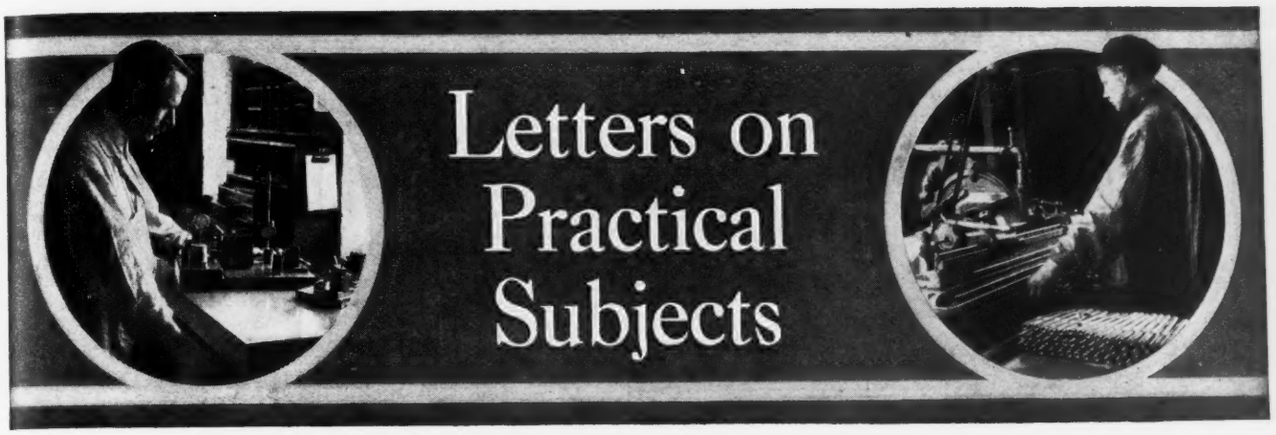


Fig. 2. Tool Equipment used in making Punch shown in Fig. 1



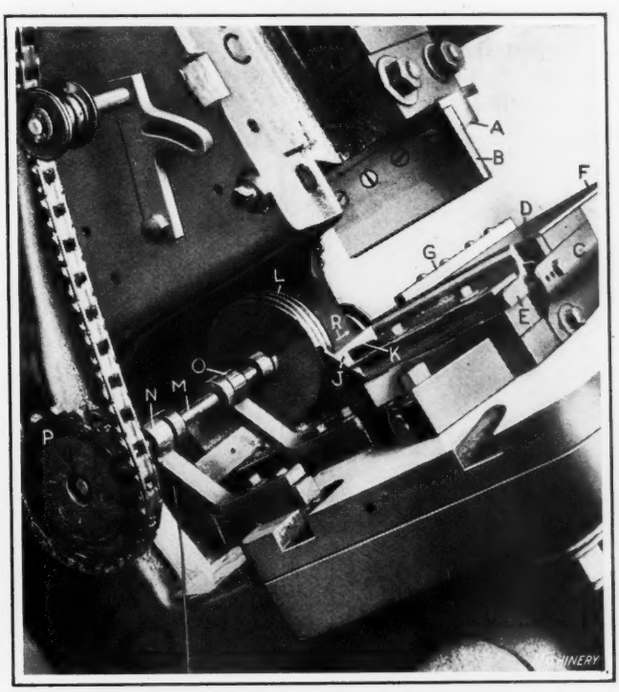
CUTTING OFF AND STACKING ATTACHMENTS FOR POWER PRESS

The press equipment shown in the accompanying illustration is designed to cut off and stack the blanks from which cylindrical tin boxes are made. The strip stock which is cut up to form blanks of the required dimension is lithographed on one side. The machine that forms, side-seams, and locks the seamed sides of a blank together to form the cylindrical part of the box has an automatic magazine feed. In order to insure the proper functioning of the feeding mechanism of this machine, it is essential that the tin blanks be uniform in width and that they be evenly stacked. The blanks, when stacked, must all face one way, so that the lithographed surface will be on the outside of the completed box.

As shown in the illustration, the press equipment for cutting off the blanks consists mainly of the machine-steel shear-holder *A*, the upper shear blade *B*, the casting *C*, which contains the lower tool-steel blade *D*, and the angle-iron stop *E*. The ⅛-inch plate *F* is secured to the top of casting *C* and serves as a table. The cold-rolled steel strip *G* guides the stock when it is fed to the shears. The casting *C* is machined or cut down on the back side to form a table on which the blanks are stacked. A cold-rolled steel strip *J*, attached to the edge of this shelf acts as a stop for the blanks as they slide down the chute, which is located below stop *E*. The strip *J* also forms a pocket for the stacked blanks.

The sheet-metal guide *K* is bent so as to bring the blank up on its edge when it slides down the chute, thus guiding it into the deep thread groove of the conveying worm *L*, which is pinned to shaft *M*. Shaft *M* is supported by the bearings *N* and *O* and is revolved by the sprocket *P*. Sprocket *P* is driven by a chain connected to a sprocket on the crankshaft of the press. The thread of the conveying worm is so thin and deep that it has more the appearance of a series of thin disks than an actual thread.

When the press is in operation, a strip of the lithographed tin is fed along the table *F* over the shear blade *D* until it comes in contact with stop *E*. The shear *B* then cuts off the blank, which drops into the chute below stop *E*. As the press is inclined backward, the blank slides down the chute on edge and, passing into the thread groove of the conveying worm, is stopped by the strip *J*. The conveying worm then carries the blank sidewise in the direction indicated by the arrow *R*. The blanks are thus stacked in the long pocket at the back of the guide *G*. A block of iron is placed in the pocket to prevent the blanks from falling over. As the blanks accumulate they push this block along the table or pocket. When a sufficient number of blanks has been stacked, the operator transfers them to the magazine of the machine previously mentioned, which performs the seaming and forming operations. The press, when in operation, is equipped with guards which enclose the shears. The guards are not shown in the illustration, as they were removed in order to give a better view of the shears and the conveying worm. When the press is in use the ram operates continuously at a speed of ninety strokes per minute.



Attachments used on Inclinable Power Press for cutting off and stacking Tin Blanks

Brooklyn, N. Y. S. A. McDONALD

PERFORATING AND EMBOSSING DIE FOR FIBER PARTS

In Fig. 1 is shown a die for perforating, slitting, embossing and cutting off fiber stock to form the pole piece insulator shown in Fig. 2. The fiber stock from which this part is made is obtained in strips 72 inches long by 3 1/16 inches wide by 0.015 inch thick. The die is used on an inclined press, the stock being guided by the slot in stripper plate *A*. In operation, the stock is fed in from the right-hand side until it strikes the first finger-stop *B*. The punch *C* then perforates the slot in the center of the blank, as shown in Fig. 2, after which finger-stop *B* is released and the stock passed on to the second stop *D*. In this position punches *E* and *F* (see Fig. 3) emboss a rectangle on the blank, as indicated in Fig. 2, while punches *G* which are set 0.020 inch lower than the embossing punches cut four angular slits extending from the small slot to the corner of the embossed rectangle. The slits cut by punches *G* are indicated by dotted lines *H* in Fig. 2.

After the embossing and

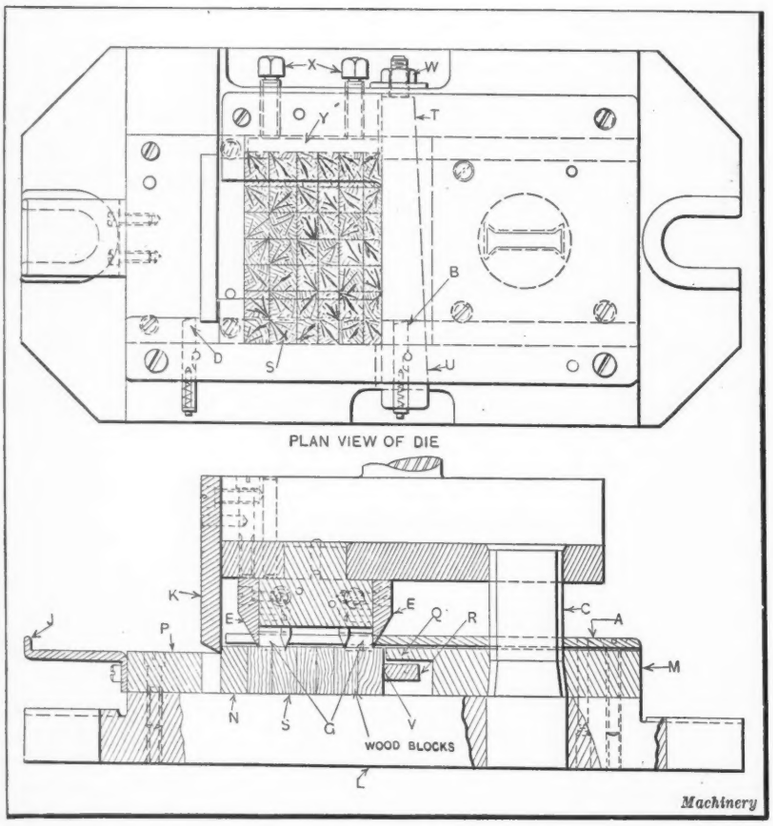


Fig. 1. Perforating and Embossing Die for producing Fiber Part shown in Fig. 2

slitting operation, the stock is fed on until it strikes stop *J*, when it is cut off by blade *K*. The edge of the cutting-off blade is ground at an angle with the face of the die *N*. As the press is inclined, the finished pieces slide out at the back, leaving the die clear so that the stock can be fed forward to permit the next blank to be cut off.

It will be noted that the die *S* is built up of wooden sections sunk into a slot in die-shoe *L*. Block *P* is simply a filler piece. The perforating die *M* has an overhanging ledge *Q* which just clears the wedge *R*. It will be noted that the embossing and slitting operations are performed on the wooden die or base *S* which is so constructed that the punches *G* enter the blocks on their ends or cross-sectional surfaces. Wedge *R* bears against the die-holder at points *T* and *U* and against the wooden blocks at *V*. When nut *W* is tightened, the wooden blocks of die *S* are clamped against block *N*. Clamp *Y*, being acted upon by set-screws *X*, also exerts a clamping action on the wooden blocks. The reason for making up this die of a number of small wooden pieces is that a more compact surface is obtained and at the same time there is sufficient "give" for the slitting punches to perforate the wood deep enough so that the embossing punches can perform their work.

Brooklyn, N. Y. JOHN A. HONEGGER

SIMPLE METHOD OF TESTING LUBRICATING OIL

The following method of testing lubricating oil should be of interest to purchasing agents and engineers of manufacturing plants where the services of a chemist are not available. It is important that lubricating oils be free from acids, that they have the proper body, and that they be free from gum. To test for acids, pour some of the oil in a glass, together with a small quantity of litmus solution, and heat the glass in warm water. If the solution turns red, it indicates that there is acid in the oil. If it remains blue, the oil contains practically no acid.

In order to examine the oil for "body," take a long piece of glass and place it in a slanting position. Pour some drops of the oil to be tested on the highest point of the glass. It is obvious that the oil which runs the farthest is that which contains the least body. To test for gum, allow the oil in the second test to stand for a few hours. Then proceed to rub the oil off. Should the oil feel sticky, it indicates that it is mixed with plant or gum oil which is detrimental to the machinery.

Groveside, Hoosick Falls, N. Y. LAWRENCE E. OLSEN

DIE FOR SLOTTING SIDES OF COIL SPRING

The die shown in the accompanying illustration is used to cut slots in the sides of a coil spring. The spring is shown in the upper left-hand corner of the illustration and also in the die at *X*, by heavy dot-and-dash lines. The slots are cut by two punches *A* and *B*, which are staggered, so

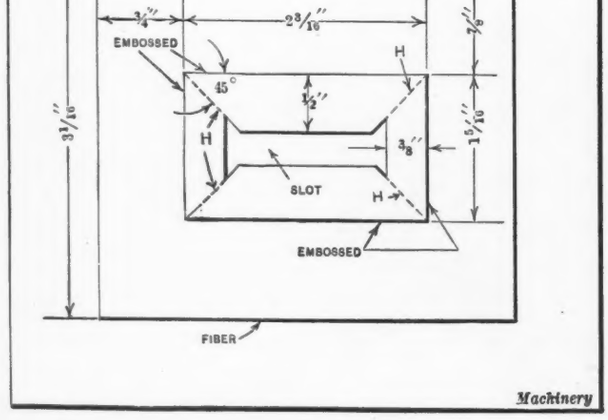


Fig. 2. Fiber Pole Piece produced in the Die shown in Fig. 1

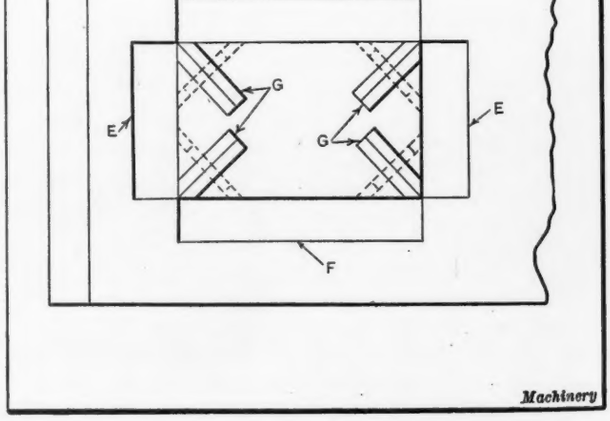


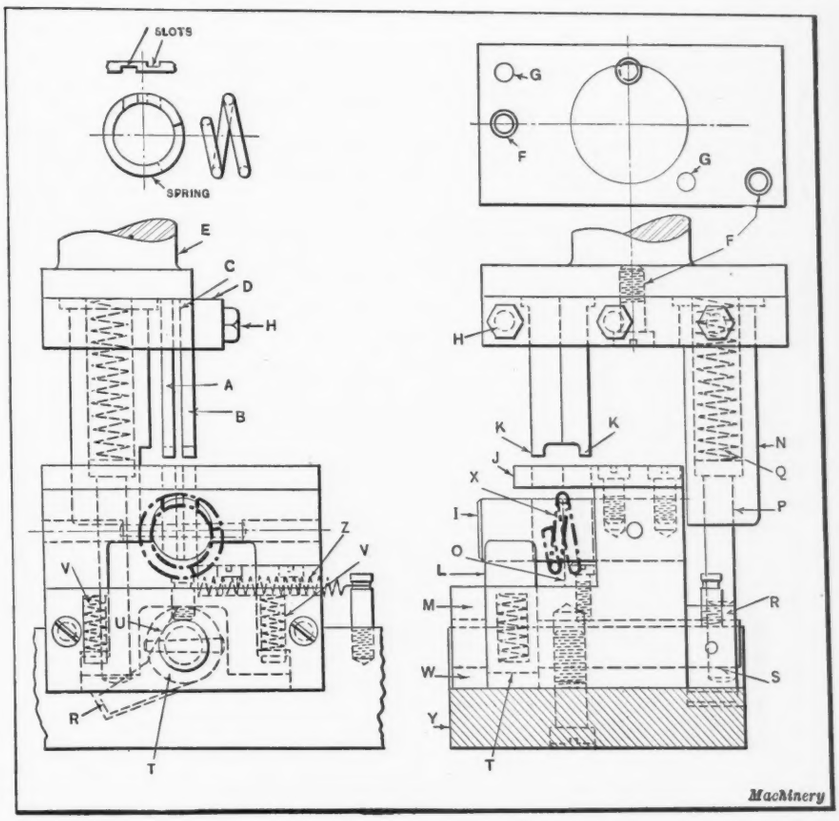
Fig. 3. Diagrammatic Plan View of Slitting and Embossing Punches

that one cut is made on each side of the spring stock. The punches are held in the block *C* by means of a clamp *D*. Block *C*, in turn, is held to the holder *E* by screws and dowels *F* and *G*, while screws *H* are employed to tighten the clamp. The spring is slipped over the arbor *I*, which has a groove on its upper side. This groove locates the work while the slots are being cut. The arbor is also slotted to serve as a die.

A plate *J* guides and backs up the punches. The punches are provided with steps *K*, so that they will be backed up by the arbor before coming into contact with the work. When the work is placed on the arbor, block *L* is in the lowered position, which it automatically assumes on the up stroke of the press. Various parts of the block lowering and raising mechanism are contained in the steel block *M*. The block-raising device is actuated by plunger *P*, which is backed up by spring *Q*. Plunger *P* is held in a sleeve *N*, which is attached to block *C*. As the punch-holder descends, plunger *P* comes in contact with a pawl *R*, which is attached to a short stud *S* by means of a pin. The head *T* of stud *S* has a flat *U* milled on one side which acts as a cam to raise block *L*. Block *L* is slotted so that it fits over the head *T* of the stud, with which it is held in contact. This contact between the two members is maintained by springs *V*. As pawl *R* is pushed down by plunger *P*, it causes block *L* to be raised into contact with the arbor *I* by means of the lift or cam surface *U*. Thus it will be apparent that block *L* braces the outer end of the arbor while the punches *A* and *B* are cutting the slots in the spring. The plate *W* serves to support the outer end of stud *S*. Block *M* is attached to the shoe *Y*, which is grooved out to receive it.

In operation, plunger *P*, on the down stroke of the press, pushes pawl *R* completely down so that block *L* will be raised into the arbor-supporting position, after which the continued downward movement of the ram causes spring *Q* to be compressed. A spring *Z* attached by a grooved pin to pawl *R* and to the base of the casting, exerts a pull on the pawl, thereby allowing block *L* to be pushed back clear of the arbor by the springs *V* on the upward stroke. Sleeve *N* is flattened on one side to provide clearance for block *M*. It is simply necessary to put the work on the arbor and remove it after the down stroke. A plate *O* is used to locate the work, the end of the spring being placed in contact with this block. As the punch ascends, all parts return to the inoperative position and the operator replaces the slotted spring by a new piece of work. As the two cuts balance each other, they have a tendency to prevent the spring from twisting.

H. M.



Die used for cutting Slots in the Sides of a Coil Spring

IMPROVISED ATTACHMENT FOR BEVEL GEAR CUTTING

Two bevel gears were required in the construction of a new machine developed at a certain plant. As the plant was not equipped for cutting the gears, it appeared that they must be purchased or that a machine cutting them

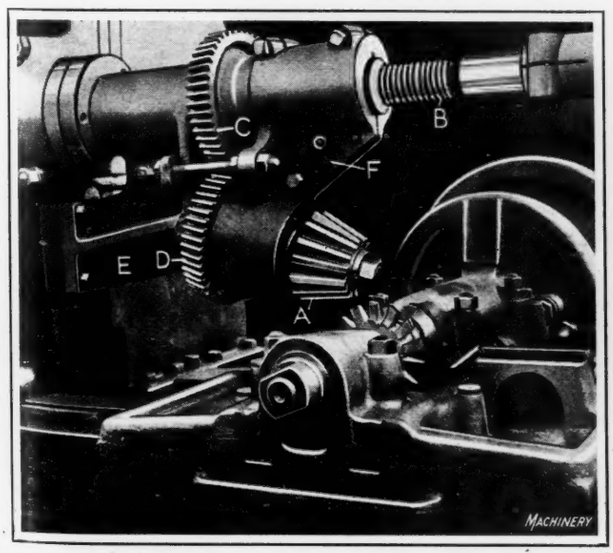


Fig. 1. Attachment for cutting Bevel Pinion on Spur Gear Machine

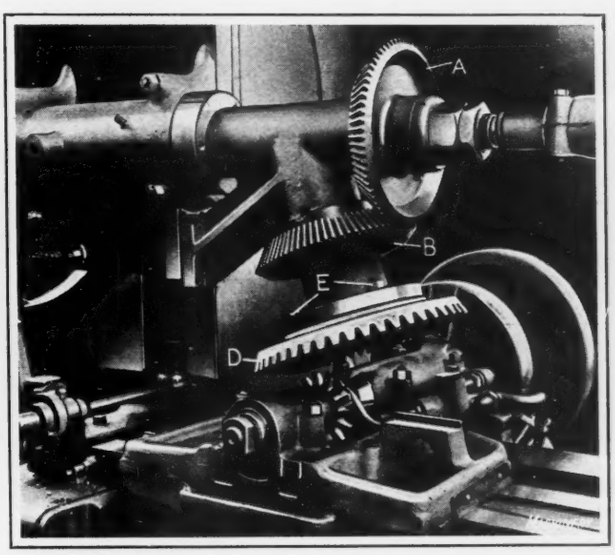


Fig. 2. Attachment for cutting Bevel Gear for Pinion shown in Fig. 1

must be added to the shop equipment. The first plan, that of purchasing the gears, did not appeal to the management, as it was the practice to manufacture all parts at the plant. The second plan did not seem feasible, because the newly developed machine on which the gears were to be used had not been on the market for a sufficient length of time to show that the demand for it would warrant the purchase of new equipment.

The problem was finally solved, however, by designing and making the bevel gear cutting attachments shown in the accompanying illustrations. These attachments were designed for use on a Gould & Eberhardt spur gear cutting machine. The bevel pinion *A* shown in Fig. 1 has fourteen teeth, and the mating gear shown at *D* in Fig. 2, has forty-eight teeth. The teeth are 2½ diametral pitch, making the pitch diameter of the large gear 19.2 inches, and that of the pinion 5.6 inches. The attachment for machining the pinion *A*, Fig. 1, consists of an arbor *B*, which is fastened to the head of the gear-cutting machine and driven by it in a manner similar to that employed in machining a spur gear. Fastened to the arbor is a gear *C* which meshes with another gear *D*. The second gear is fastened to the work-shaft which is supported by brackets *E* and *F*. The angle that the center line of the pinion arbor makes with the horizontal or the line of travel of the cutter is 15 degrees 15 minutes.

In Fig. 2 is shown the attachment used in cutting the teeth in the bevel gear. It will be noted that this device is similar in construction to the attachment used in cutting the pinion. The angle between the axes of gears *A* and *B* is such that the angle formed by the axis of gear *D* with the horizontal is 74 degrees 45 minutes. This angle, it will be noted, is complementary to the pinion angle. Gear *D* is held to the flanged end of gear *B* by bolts *E*. The gear-cutting attachments described gave excellent results and were used for several weeks until orders for the new machine on which the bevel gears were used warranted the purchasing of a standard bevel gear cutting machine.

Providence, R. I. ROBERT MAWSON

DEGREE OF CURVATURE

The term "degree of curvature" is not clearly understood by the majority of mechanical draftsmen, as its use is confined chiefly to railroad practice. Consequently, many mechanical draftsmen are at a loss as to how to proceed to lay out a curve of a given degree of curvature unless there is available a table of corresponding radii, or a railroad curve with the required degree of curvature and the equivalent radius stamped on it. Briefly, the degree of curvature is the angle at the center of the curve subtended by a chord 100 feet in length. Thus it is evident that the greater the radius the smaller will be the degree of curvature, and vice versa.

The problem of determining the radius for a given degree of curvature is one of simply finding an equation that will give the hypotenuse of a right-angled triangle having an included angle equal to one-half the degree of curvature, and the short side equal to one-half the chord length, or 50 feet. Letting *D* equal the degree of curvature and *R* the required radius, we have the formula,

$$R = \frac{50}{\sin\ (D \div 2)}$$

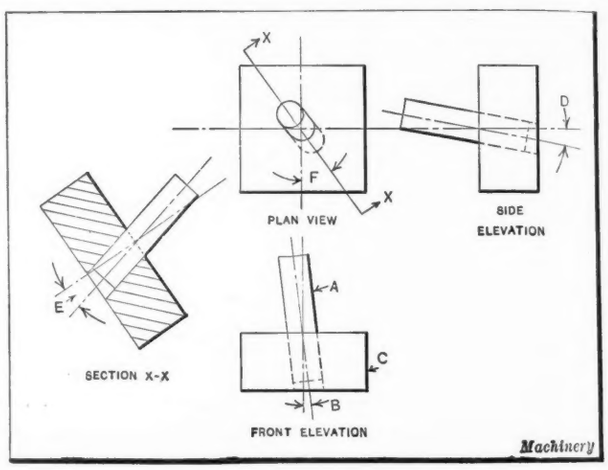
Thus, for example, if we desire to find the radius *R*, in feet, of a curve having a degree of curvature of 25 degrees, we have:

$$R = \frac{50}{\sin 12 \text{ degrees } 30 \text{ minutes}} = \frac{50}{0.21544} = 231.01$$

Baltimore, Md. HENRY R. BOWMAN

CALCULATING RESULTANT ANGLES

Draftsmen and machine designers sometimes find it necessary or desirable to calculate what is commonly termed "the resultant angle." This problem is frequently met with in making drawings for automobile and airplane parts. A clearer understanding of the problem, as it is encountered in practice, will be obtained by referring to the accompanying illustration. Suppose, for instance, that pin *A* is set at a given angle *B* with respect to the block *C*, as shown in the front elevation view. Now assume that pin *A* is also tilted to another given angle *D* in a different plane, as indicated in the side elevation. It is evident that the resultant angle *E* must be known by the workman in order to enable



Resultant Angle Problem

him to drill the hole for pin *A* at the correct angle in the plane of section *X-X*. First it is necessary to calculate angle *F* from the given angles *B* and *D*. When this angle has been determined, the draftsman can lay out the plan view quickly and with greater accuracy than would ordinarily be obtained by the projection method. It might be mentioned here that similar calculations are required in determining the position and the angle of inclination of the edge that is formed by two converging sides of a pyramid or wedge.

Referring to the accompanying illustration, let it be assumed that the front and side elevations showing the pin and block have been drawn and that the draftsman has also drawn the plan view of the block. In order to show the pin in the plan view, it is necessary to determine angle *F*, after which angle *E* may be readily calculated. The formulas for obtaining these angles are,

$$\text{Tan } F = \frac{\tan B}{\tan D}$$

and

$$\text{Tan } E = \sqrt{\tan^2 B + \tan^2 D}$$

As an example showing the use of these formulas let it be assumed that angle $B = 7$ degrees and angle $D = 10$ degrees. (See illustration.)

Then

$$\text{Tan } F = \frac{\tan\ 7 \text{ degrees}}{\tan 10 \text{ degrees}} = \frac{0.12278}{0.17633} = 0.69631$$

Thus

$$F = 34 \text{ degrees } 51 \text{ minutes}$$

Now

$$\text{Tan } E = \sqrt{\tan^2 7 \text{ degrees} + \tan^2 10 \text{ degrees}}$$
$$= \sqrt{0.12278^2 + 0.17633^2} = 0.21487$$

Therefore

$$E = 12 \text{ degrees } 7 \text{ minutes}$$

Cleveland, Ohio EDWARD HELLER

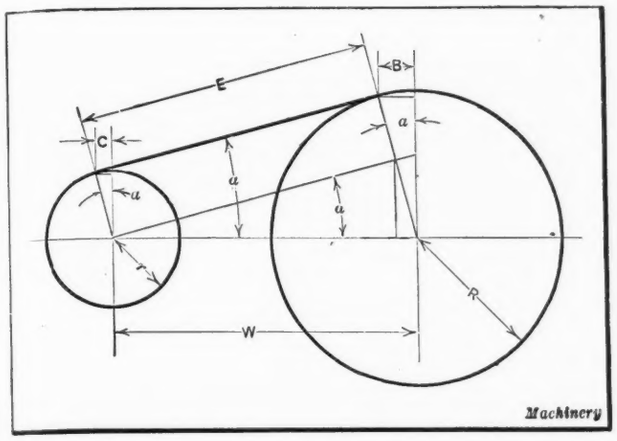


Fig. 1. Diagram used in finding Dimension E

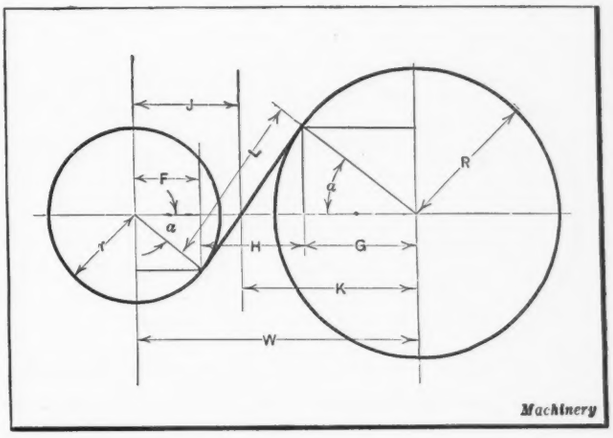


Fig. 2. Diagram used in calculating Dimension L

DETERMINING LENGTH OF TANGENT TO TWO CIRCLES

In tool-room work it frequently becomes necessary to determine the length of a tangent to two circles. Referring to Fig. 1,

R = radius of large circle;
r = radius of small circle;
W = center distance between circles; and
a = angle formed between the tangent and the horizontal center line.

With the values given it is required to find the following:

E = length of tangent;
B = length of horizontal line from point of tangency on large circle to the vertical center line; and
C = length of horizontal line from point of tangency on small circle to the vertical center line.

Now by trigonometry,

$$\text{Sin } a = \frac{R - r}{W} \text{ and } E = W \cos a$$

$$B = R \sin a \text{ and } C = r \sin a$$

When the tangent crosses a line passing through the centers of both circles, as shown in Fig. 2, the solution is somewhat different. In solving the latter problem let

R = radius of large circle;
r = radius of small circle; and
W = center distance between circles.

The dimensions that are required to be found are:

L = length of tangent;
F = length of horizontal chord from point of tangency on small circle to the vertical center line; and,
G = length of horizontal chord from point of tangency on large circle to the vertical center line.

By trigonometry we have

$J = r \sec a$; $K = R \sec a$; and $W = J + K$; or by substitution,

$$W = r \sec a + R \sec a = (r + R) \sec a$$

Now

$$\text{Sec } a = \frac{W}{R + r}$$

Also

$F = r \cos a$ and $G = R \cos a$

By subtraction,

$H = W - F - G$

Hence

$H = W - r \cos a - R \cos a$

or

$H = W - (R + r) \cos a$

Then, $L = H \text{ cosec } a$

By substitution, $L = [W - (R + r) \cos a] \text{ cosec } a$

These formulas are of considerable value in laying out complicated profile gages.

Flint, Mich. W. G. HOLMES

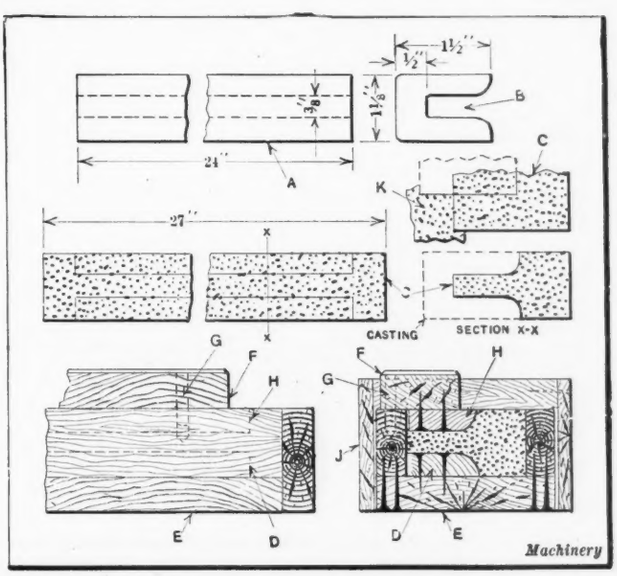
MAKING STEEL CASTINGS WITH LONG STRAIGHT SLOTS

Steel castings of the shape shown at A in the illustration are used in the construction of a certain type of monorail hoist. These castings are generally cut into short sections, 3, 3½, and 4 inches in length, as conditions demand. It is necessary that the slot B in the castings, as well as the casting itself, be straight and smooth. Slot B in the first lot of castings made was formed by using a flat slab core, but this method proved rather expensive, as considerable grinding was necessary to round the corners of the slot. The patterns were therefore changed so that a core of the shape indicated at C could be used, thus eliminating the grinding operation.

The first cores of this type to be used were made up by pasting two half cores together. This method of making a full core was unsatisfactory because of the difficulty of obtaining straight and flat core-drying plates. The concave and convex surfaces on the half cores formed by the uneven surfaces of the core-drying plates made it impossible to obtain a true straight core by pasting two halves together. To overcome this difficulty, the full core-box shown in the lower right-hand corner of the illustration was developed.

The piece D is fastened to the core-box E. The loose piece F is located and held in position on box E by the dowel-pins G. Piece H is fastened to F as indicated. The plain frame J, which has sides and ends only, is a loose fit around the outside of the core-box E. The sides of the frame J extend ½ inch above box E. The pattern proper (not shown in the illustration) is a plain rectangular piece, cut away at the corners to leave a square section K at each end of the mold. These square sections serve as stops or locating surfaces for the core C.

In molding the core, frame J is removed and the core sand filled into the slot by hand, and struck off in the usual manner. The loose



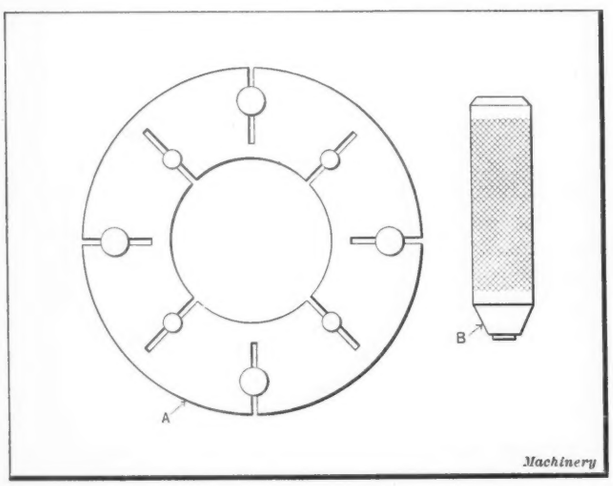
Method of making Straight Cores for a Slot in a Steel Casting

pieces *F* and *H* are then lifted off. Frame *J* is next placed over the core-box in the position shown, and black or molding sand filled in and struck off even with the top of the frame. The finished core is rolled over on the drying plate, after which the frame *J* and core-box *E* are removed. The core then rests on the black sand base, ready for baking.

Kenosha, Wis. M. E. DUGGAN

RENEWABLE PLUG GAGES

Plug gages used for checking ground holes are worn down rapidly by the abrasive left on the work. Consequently the maintenance of gages for this kind of work is a source of considerable expense in some plants. In order to reduce this expense, an adjustable or renewable plug gage was designed which eliminates the necessity for scrapping the gage when it has been worn so that it is slightly under size. A gage of the renewable type is shown at *A* in the accompanying illustration. It will be noted that slots are cut at intervals around the edge and that taper pins are provided to permit the slotted segments to be expanded.



Plug Gage that can be expanded when Worn and relapped to Size

When the gage has been worn under-size the taper pins are driven into the gage and the outside lapped down to size. When in use the gage is fitted with a handle. A punch such as shown at *B* is provided for driving the pins into the gage. This punch was designed to drive each pin in the same distance, in order to insure uniform expansion. The projecting points of the taper pins are ground off flush with the body of the gage after being set. Alternate pin-holes are tapered from opposite sides.

Rochester, N. Y. GEORGE C. HANNEMAN

PLANING SIDES OF DEEP RECESS

Occasionally work having a deep recess, like that shown at *A* in Fig. 1, is sent to the planer to be machined. Here difficulty is often experienced in planing the sides of the recess. Tools of the usual type having sufficient length to reach the bottom of the recess are too springy and cannot be relied upon to do accurate work. Gooseneck tools have been used to a considerable extent for this kind of work, but they are generally unsatisfactory. The arrangement shown in Fig. 2 for planing the sides *B* and *C* of the recess in the trunnion bearing casting shown in Fig. 1 proved very satisfactory. The rigid manner in which the tool-bar *D* was secured enabled the sides of the recess to be planed parallel and accurate within the close limits demanded.

The special holder *F*, Fig. 2, is split and provided with a clamping screw which enables the bar *D* to be held firmly in place. The upper end of holder *F* is turned down to a

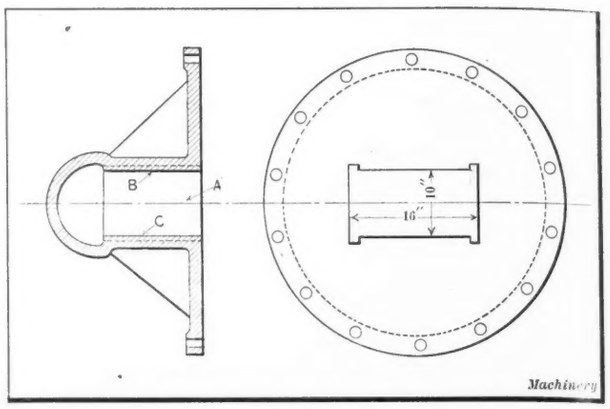


Fig. 1. Casting with Deep Recess machined on Surfaces B and C

nice fit in the hole in the square block *E* which is secured to the clapper-box. This construction permits no vertical movement, but allows bar *D* to be pivoted in a horizontal plane. The rear support for the tool-bar consists of a trunnion sleeve *G* mounted in two bearings *H* and *J* which, in turn, are bolted to a cast-iron cross-piece *K*. The cross-piece is rigidly secured to the rear of the planer housing. The rear bearing also permits a horizontal movement and allows the bar to be slid in and out, but does not permit a vertical movement. The two bearings were carefully tested for even height before sliding the bar *D* into place. All feeding movement of the tool in a vertical direction is done by loosening the set-screw *N* and adjusting the tool itself. The regular cross-feed of the planer head is used, to feed the tool across the face of the work, the bar *D* being swung from the position indicated by the dotted lines at *L* to that indicated by the dotted lines at *M*, in the upper view.

Allentown, Pa. JOE V. ROMIG

* * *

Statistics of the Department of Commerce covering automobiles for 1921 indicate that of the 1,435,000 passenger cars built, 968,000 sold for $800 or less; 298,000 sold for from $800 to $1500; 128,000 sold for from $1500 to $2500; 33,300 sold for from $2500 to $3500; and 7870 were sold at a price above $3500. About 147,000 motor trucks were built, of which 27,000 were of ¾ ton capacity or less; 96,000, from 1 to 1½ tons; 16,500, from 2 to 3 tons; 6420, from 3½ to 5 tons; and 1100, over 5 tons.

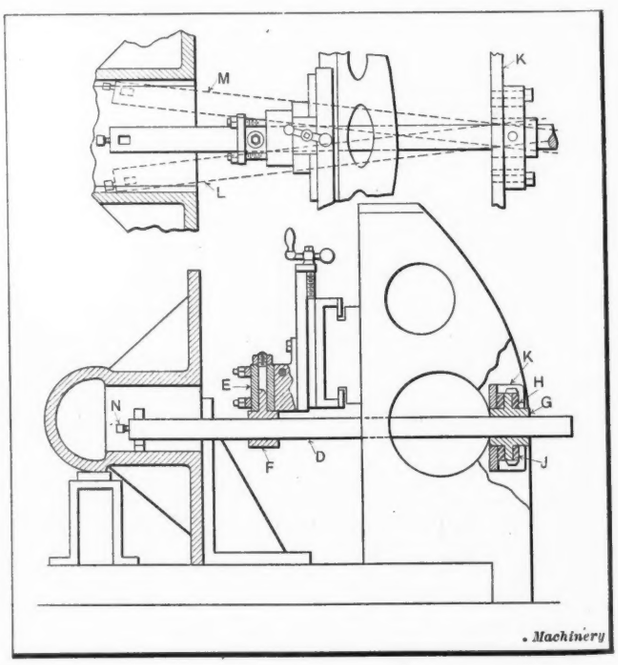


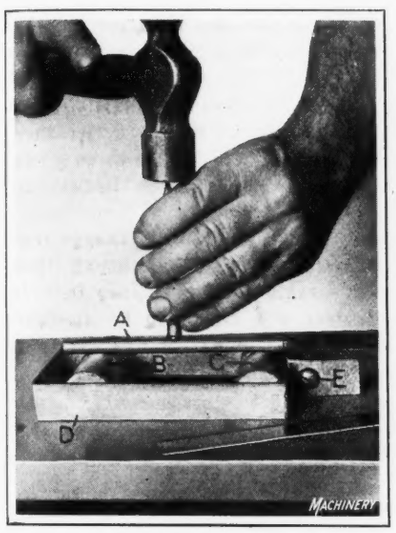
Fig. 2. Planer Set-up for machining Work shown in Fig. 1

Shop and Drafting-room Kinks

STRAIGHTENING SMALL SHAFTS

The fixture shown in the accompanying illustration was designed for use in straightening small shafts such as the one shown at *A*. Many of the shafts were bent slightly in one place only, while others were bent in two and some even in three places in a length of approximately 6 inches. While the work did not call for extreme accuracy, the shafts were required to be straight in the generally accepted sense of the word.

The straightening fixture consists simply of two pieces of round cold-rolled steel *B* and *C* enclosed by a strip of sheet metal *D*, the ends of which are brought together and secured with a machine screw *E*. A V-groove is cut in the middle of each roll to hold the shaft in place while it is being straightened by means of a hammer and punch. A flat plate held at a convenient distance above the bench is used to test the shafts for straightness. As the shafts are rolled along this flat plate, any bends are easily detected by a "light" test.



Method of straightening Small Shafts

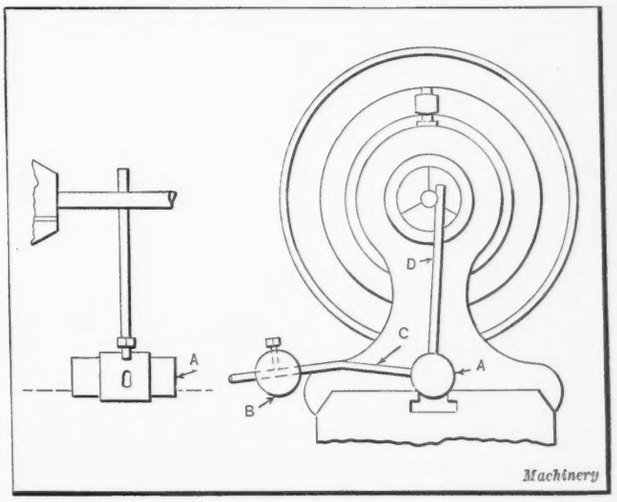
After marking the bent places on the shaft with chalk, it is placed in the vees of the rollers to be straightened. The rollers are then rolled in or out the required amount to permit proper straightening, as determined by the chalk lines. For instance, if a shaft were bent at one end in one direction and in the opposite direction at the other end, the rollers would be brought together to support the shaft at each side of one bend for the first straightening operation, after which the rolls would be rolled further apart to permit the whole length to be straightened. It will be noted that the large end of the punch is placed in contact with the work when straightening a shaft. The fixture shown was quickly made up and it answered the purpose remarkably well.

Rosemount, Montreal, Canada HARRY MOORE

BENCH LATHE STEADYREST

Most toolmakers who have ground small cylindrical pieces on a bench lathe with the work held in the draw-in collet have experienced difficulty in obtaining a good finish that is devoid of chatter marks. The accompanying illustration shows a simple steadyrest that has been found of assistance in overcoming this difficulty.

The part *A* is made of machine steel and is about ¾ inch in diameter by 1⅜ inches long. A piece of machine steel *B*, about ¾ inch in diameter by ¾ inch long is adjustably mounted on rod *C*. Thus the pressure exerted on the work by the arm *D* can be easily adjusted to counteract the pressure of the grinding wheel by moving weight *B* in or out as conditions require. The part *A* simply rests in the T-slot in the bench laid bed. When new work is to be inserted, the whole steadyrest outfit can be easily laid aside. D. R. G.

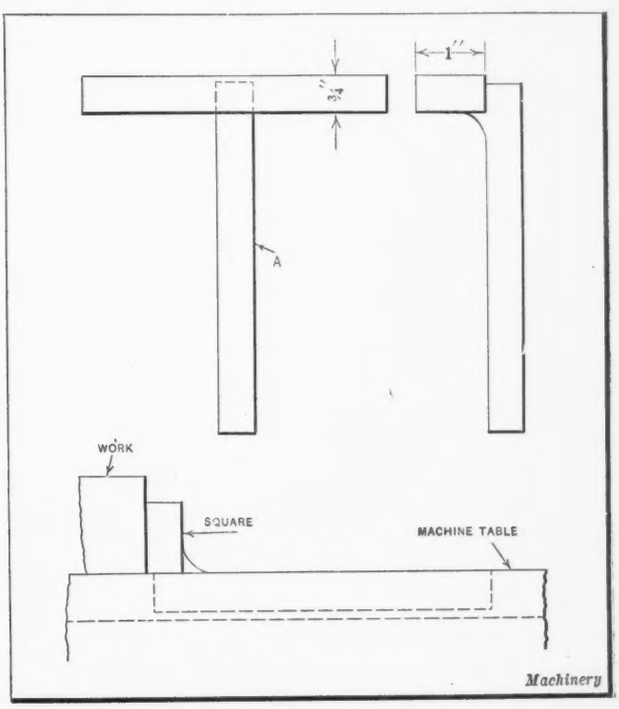


Steadyrest used in grinding Small Cylindrical Work on a Bench Lathe

MACHINE SQUARE

The simple tool shown in the accompanying illustration is designed for use in squaring up work on machine tool tables. It is hardened and ground, and will remain accurate for a long time, as it is forged in one piece. The lower part *A* is made to fit the T-slot in the machine tool table. The dimensions given in the illustration are for a light machine square suitable for use in the tool-room. Larger sizes adapted for use on heavy machine tools will also be found useful. The lower view in the illustration shows clearly the method of using the square.

Ontario, Cal. CHARLES HOMEWOOD



Square for locating Work on Machine Table

Questions and Answers on Practical Subjects

SHADED LINES ON DRAWINGS

E. R. P.—What is the present practice regarding the use of shaded lines on machine drawings? At one time most of the leading machinery manufacturers seemed to favor shading. While it requires a little longer to make a shaded drawing, it seems to me that this slight additional expense is well worth while.

A.—Very few working drawings are shaded at the present time. While it is true that shading does make some drawings clearer, the advantage in this respect is slight in most cases, and is not considered worth while by a large percentage of the machinery manufacturers in this country. This applies to detail or working drawings particularly. Assembly drawings are sometimes shaded, especially when they are to be used for purposes of illustration. Patent Office drawings are also shaded, as well as the line illustrations used in many technical periodicals and books.

CHECK MARKS ON STEEL TOOLS

J. A. P.—When grinding high-speed steel tools very small cracks or check marks sometimes appear on the surface. What is the cause of this and how can it be prevented?

A.—The cracking or checking which sometimes occurs when grinding high-speed steel tools is attributed to the use of cooling water while rough-grinding the tool, especially if excessive pressure is applied. The water, playing upon the steel which is quite hot at some points due to the friction, is said to cause the minute cracks or check marks. A method of avoiding this difficulty is to rough-grind the tools on a dry wheel before hardening. The tool is rough-forged approximately to the required shape, and it should preferably be ground slowly at first until the steel has been heated somewhat; then the grinding may be done quite rapidly without injuring the tool, but water should not be used during this preliminary grinding.

IS AN UNREGISTERED TRADEMARK VALID?

M. L. H. Co., Inc.—We have been using a trademark for the last few years, but have failed to have it registered in the U. S. Patent office. Are we protected, and what is the value of a trademark?

ANSWERED BY GLENN B. HARRIS, YONKERS, N. Y.

You have a right to your trademark under the common law, but when registered you have *prima facie* evidence of ownership. The decision of one U. S. Court, should litigation develop, will in most cases be given full credit in all of these courts.

The value of a trademark consists of an assurance to a manufacturer or merchant of protection in the exclusive use of the name, sign, or symbol, by which his product becomes known. The trademark is a guarantee of the genuineness of the marketed article, and may be said to be, in this respect, the commercial substitute for an autograph. The trademark distinguishes the goods of one manufacturer or merchant from those of another. Thus he is enabled to secure such profits as result from a reputation for superior skill, industry, or enterprise, or from the expenditure of large sums of money for advertising purposes. The protective value of the trademark may be compared with the protection afforded by a fundamental patent, as the trademark is used not only in connection with patented articles, but also with commodities not patented nor patentable.

TENSILE STRENGTHS OF DIFFERENT MATERIALS

G. H. T.—What is the tensile strength of ordinary cast iron, and how does it compare with semi-steel? Also please give the tensile strength of steel castings and steel forgings.

A.—The tensile strength varies considerably for different compositions, especially in the case of steel, and should be determined by actual test when accuracy is essential. The following figures are intended only as a general guide and represent values commonly used in design when adequate factors of safety are allowed and the exact value for the tensile strength is not necessary.

The tensile strength of gray cast iron is ordinarily given as 15,000 pounds per square inch. Semi-steel may be anywhere from 25 to 60 per cent stronger than gray cast iron. Some semi-steels may have 10 per cent of steel, whereas others have double this amount, which affects the strength decidedly.

The tensile strength of steel castings ordinarily varies from 60,000 to 80,000 pounds per square inch. In fact, these are the minimum and maximum figures for the three grades of steel castings specified by the American Society for Testing Materials.

As to steel forgings, the strength ordinarily ranges from 75,000 to 90,000 pounds per square inch, although these values are subject to considerable variation, since they depend upon the kind of steel and may also be decidedly affected by changes in physical properties due either to forging processes or heat-treatment.

BENDING BUTT-WELDED PIPE

M. L. F.—When bending butt-welded pipe, should the seam be at the side of the bend in preference to the inside or outside of the curve? When the seam is on the outside of the curve it is where the greatest stretching of the metal occurs, but one contention is that since this stretching is in line with the seam, there is less tendency to cause rupture than when the seam is at the side of the bend.

A.—This question was submitted to a prominent manufacturer of pipe and tubing, and the following information obtained.

The general practice in bending butt-welded pipe is to have the seam at the side of the bend. This is based on the assumption that in making a bend, the neutral axis is midway between the inner and outer curves, and therefore this part of the pipe is not subjected to extension or compression while bending. If the method of bending or the equipment used conforms to the assumption referred to, then the foregoing rule is correct; but in actual practice there is more or less deviation, depending on the type of equipment and the nature of heating. For example, it has been found in some experiments in making hot bends according to the best practice, that curvature is more the result of compressing the material on the inside then stretching it along the outer curve. In such cases, the neutral axis would lie somewhat outside the center line. One manufacturer, who has been very successful in making bends, lets a stream of water flow over the outer curve, while making a hot bend, so that practically the entire bend is obtained by compressing the material. This is considered good practice, since there is a minimum stretching and thinning of the pipe wall. When this method is employed, the seam should be along the outer curve because in any other position there would be a tendency toward buckling or shearing stresses which might result in splitting.

CHECKING DRAWINGS

By WILLIAM H. KELLOGG

The detection of errors in a complicated detail drawing requires extreme care on the part of the checker. Even the most proficient find it difficult to locate all the errors without making a systematic and painstaking search. With reference to checking lists, the writer might mention that he read with interest the article "List for Checking Drawings" in May MACHINERY on page 739. The practice described in the present article, which relates to the same subject, is not intended to be taken as a hard-and-fast rule, but it covers several points that the writer's experience has proved desirable. It is the writer's belief that when a good rule or program is once mastered by a worker in any line it is not necessary for a written outline to be kept constantly before him. Nevertheless, a good method of checking must consist of a complete program covering various classes of investigation. It must be so arranged that when completed every practical point involved in the drawing will be covered.

The most difficult errors to detect are those of omission. A mistake in dimensioning may be found by checking the figures carefully, but if the dimension does not appear at all, the omission may escape the checker's notice. For this reason any method of checking should include some provision for detecting errors of this nature. Obviously the best plan of procedure is to have a tabulated list of every important point that must be considered. These points should be grouped in a number of general divisions or classes of information, all of which go to make up the substance of the completed drawing. Each division should have a definite heading, and the entire list, although compact, must include every item that a drawing of a machine detail may contain.

The most common class to be considered in the list is that of dimensions which pertain to the body of the piece, but two other important items which may often be overlooked, are the shape or general outline of the piece and the connection or interference with other parts of the machine. This is perhaps the part of the work on which the draftsman puts most of his time, and it would be well to consider it first. In this connection, such points as pertain to molding and machining should be given careful attention.

Check List to be Memorized

The tabulated list might well be arranged in the following order: Outline of the piece and general design; finish marks or notes calling for finish all over; dimensions of the body of the piece, excluding items covered by the following class: specifications for holes and slots, including such information as required for drilling, reaming, tapping, sawing, keyseating, cutting special threads, and cutting gear teeth, etc. At this time it is also best to see that specifications for screws, bolts, and other parts are correct and listed either on the drawing in question, or in their proper place on another drawing, or in the stock list. This investigation should, of course, be arranged in accordance with the regular procedure of the concern where the work is done. The next point to be checked might be classed as special treatment, covering such operations as hardening and heat-treating, nickeling, enameling, and possibly other processes of a similar nature. Following this it should be noted if the material is correctly specified; number of parts required noted; identification or name of piece. The latter includes such items as appear in the title space—the date, scale, drawing number, name of machine or detail, and the signature of the draftsman and checker. All information on the drawing pertaining to bolts, screws, number of pieces, material, etc., should be checked in connection with the stock list or bill of material, and the assembly drawing. The pattern and part numbers should receive attention, as well as references to other drawings with their correct numbers.

The foregoing list covers the general scope of work performed on any machine detail, and when thoroughly comprehended and memorized, it becomes a program that the checker will automatically follow out without reference to the printed list. It then becomes a guide that will serve to guard the checker against all errors, as he will mentally go over all the details. Thus his mind is relieved of many worries that generally arise from going over the work in a more haphazard way. The time spent in going over the list mentally is very small in comparison to the time that might be lost if one of the many details escapes notice.

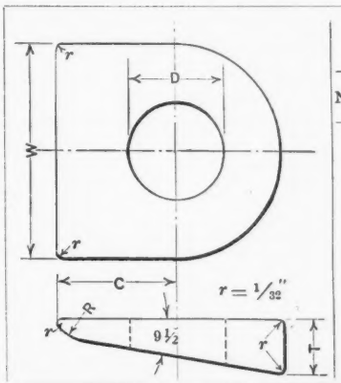
The checking of the dimensions is decidedly the greater part of the whole proceeding, and it is suggested that this part of the work be more fully systematized by a similar method of classification.

* * *

TAPERED WASHERS FOR ATTACHING HANGERS TO I-BEAMS

By MARTIN H. BALL

The attaching of hangers, brackets, auxiliary beams, etc., to structural steel members having 9½-degree tapered sections is greatly facilitated by the use of tapered washers under the heads or nuts of the fastening bolts. The accompanying table gives the specifications for a line of 9½-degree tapered washers for bolts ranging in size from ⅜ to 1 inch



Dimensions for 9½-Degree Washers

No.	Size	D	C	W	T	R
1	⅜	7/16	5/8	11/32	11/32	¼
2	½	9/16	33/32	1¼	7/16	5/16
3	5/8	11/16	7/8	1½	7/16	11/32
4	¾	13/16	37/32	1¾	½	7/16
5	7/8	15/16	1¼	2⅛	9/16	11/32
6	1	1 1/16	1 7/16	2⅜	5/8	11/32

Machinery

in diameter. The washers should be either malleable iron or mild steel castings. By using washers of this type a good bearing surface is provided for both the head and nut of a fastening bolt. The straight thin edge of the washer prevents it from turning and also serves to locate the washer in accordance with standard practice for structural steel.

* * *

In a paper on semi-steel recently read before the Institute of British Foundrymen, the author, J. Cameron, briefly reviewed the methods of making a semi-steel, and pointed out its advantages. Semi-steel is made by adding mild steel to the pig iron and scrap in the cupola. The proportion of steel used varies from 15 per cent for light castings to 40 per cent for heavy castings. The resulting metal is a high-grade cast iron with fewer impurities and better physical structure than ordinary cast iron, and while this metal has practically no elongation or ductility, it is stronger than gray cast iron under transverse, tensile, compression, and impact tests, and is superior in elasticity, toughness, and resistance to shock and wear. When properly made, it is close-grained, homogeneous, and free from hard spots and blow-holes. It is greatly superior to gray iron for machinery, and takes on a finer polish, and permits the cutting of clean screw threads. It is especially good for such castings as cylinders, pistons, and gears, and other parts which are subjected to wear and friction.

The Machine-building Industries

IN general, says a banking authority, business men can be divided into three classes: (1) Those interested only in their own factory or office; (2) those interested only in the industry in which they themselves are engaged; and (3) those who have come to realize that not only their own factory, but their entire industry, is completely interwoven in the national business fabric. It is a healthy and encouraging sign of our times that many of those in the first two classes are coming over into the third. It is with this broad and more intelligent view that MACHINERY in its monthly survey of the machine-building industries covers not only the manufacture of machine tools, small tools and shop equipment, but in broad outline, at least, reports for the whole field of industry upon which the prosperity of the machine tool business depends.

A broad review of the industrial situation shows clearly that substantial improvement has been made in the business structure. During the month of October—the last month for which complete statistics are available—substantial increases were made in production in all the basic industries. The production of pig iron and the consumption of cotton were the largest in two years—showing practically normal activities in two widely separated and basic fields of industry. The number of railroad cars loaded reached nearly a maximum, and the car shortage on this account was very severe. There is less unemployment than there has been since the end of the high pressure period in 1920; steel mills, mines, and building contractors report a shortage of skilled labor; and there has been an increase in the hours of work and in overtime employment.

The Department of Commerce notes, as the outstanding feature, the large increase in production in basic commodities, and specifically mentions that the output of pig iron, steel ingots, coke, copper, zinc, petroleum, and cement exceeds that of any previous period since 1920. It is encouraging to note that, notwithstanding many unfavorable conditions, such as coal shortage, car shortage, and delayed freight shipments, the main trend of business continues steadily upward. The export trade for October, including all classes of goods, was the largest for any month since March, 1921, in spite of the fact that exports of iron and steel declined. The liabilities in the business failures in October were lower, with one exception, than during any month since November, 1920.

The Machine Tool Industry

In the machine tool industry a marked improvement developed during the latter part of the year, although December did not bring as many new orders as previous months, due to the pre-inventory period, which always slackens the pace of trade. The railroads have been fairly active in buying machine tools, as have also the railroad equipment companies—the builders of locomotives and cars. The outlook in the railroad field for 1923 is considered good. Orders booked during the past year have been quite numerous, but much smaller as a rule, than during the period from 1915 to 1920. A great many of the inquiries have not yet resulted in orders, and if only part of these materialize, it will mean a lot of business for machine tool manufacturers in 1923. The automobile shops are continuing to buy, but in most cases their purchases are confined to special rather than standard machine tools. Further price advances are expected when conditions improve and the demand makes it possible to take actual costs into consideration.

In the special machinery field there is healthy activity. Firms designing special equipment say that their business has shown marked improvement. The demand for gear-cutting machinery is probably better than for most other classes of machine tools, and one of the leading plants in this field runs at two-thirds capacity at least, while another is unable to handle any more business than it has on hand at present, owing to the scarcity of experienced help.

Conditions in the small tool industry continue to improve steadily. Compared with three years ago, the business is, of course, not very active as yet, but in comparison with a year ago it is in very satisfactory shape. Generally speaking, the present year closes with an average amount of business in this field of about double what it was at the end of 1921. Business in metal-cutting and woodworking circular saws is good—a reflection of the activity in the steel mills, saw mills, and woodworking industries.

One of the difficulties the special tool shop still has to contend with is price-cutting by shops determined to obtain work at any cost. In some instances these shops obtain business at an actual loss, because the prices quoted are so low that they barely pay for material and direct labor. In one extreme instance the bids originally varied from $600 to $1100, but the work was finally let at $380.

The Iron and Steel Industry

Unfilled orders on the books of the U. S. Steel Corporation have been steadily rising during eight consecutive months and are now the largest in two years. The corporation operates at over 80 per cent capacity, and although independent steel manufacturers are not doing quite so well, the steel industry leads all other basic industries in recovery from post-war conditions. There are indications that when complete statistics have been compiled for steel production during the past year, the figures will show 75 per cent above 1921, and more than 10 per cent above 1912 and 1913—the two biggest years before the war. Additional blast furnaces which have long been idle have recently been blown in.

The Automobile Industry

The production of automobiles continues with unslackened pace. The October output of 217,000 cars was probably exceeded in November, although complete figures are not yet available. Never before has the automobile industry enjoyed such a volume of sales at this time of the year. The total number of passenger cars built this year will reach nearly 2,400,000; the number of trucks built averages over 20,000 a month. The buying of trucks is scattered among practically all lines of business and over most sections of the country. This activity in the automobile industry is naturally helping automobile parts manufacturers, and one maker of automobile axles states that the present volume of business in his line is more than 50 per cent greater than last year. A survey made by one of the associations of manufacturers in the automobile field forecasts a continuance of keen competition during 1923, which will strengthen the well-established, well-managed, and well-financed companies, but is likely to put many of the weaker ones to the final test.

This ends MACHINERY'S series of reviews for the year 1922. From the very beginning, notwithstanding the great uncertainty, 1922 had a hopeful aspect and developed into a real but slow recovery for the industries of America. The political developments making for world peace and tranquility are shaping up for definite settlement in 1923. Who can doubt, with all the factors before him, that 1923 will surely see a great advance in the upward climb of the hill of prosperity?

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

Davis & Thompson Continuous Drilling, Reaming and Threading Machine. Davis & Thompson Co., 251 Reed St., Milwaukee, Wis.....401
Cincinnati-Acme Universal Flat Turret Lathe. Acme Machine Tool Co., Cincinnati, Ohio.....402
Badger Automatic Grinding Machines. Badger Tool Co., Beloit, Wis.....403
American Kron Riveting Hammer and Concrete Drill. American Kron Scale Co., 430 E. 53rd St., New York City.404
Oliver Saw Bench. Oliver Machinery Co., Grand Rapids, Mich..406
Toledo Double-crank Toggle Press. Toledo Machine & Tool Co., Toledo, Ohio.....406
Cincinnati Open-side Planer. Cincinnati Planer Co., Cincinnati, Ohio.....406
Self-contained Tilted Turret Lathe. Wood Turret Machine Co., Brazil, Ind.....407
Edlund Automatic Drilling, Countersinking and Tapping Machine. Edlund Machinery Co., Inc., Box 57, Cortland, New York.....408
Pratt & Whitney Precision Level. Pratt & Whitney Co., Hartford, Conn.....408
Beaudry Taper Hammer Die. Beaudry & Co., Inc., 45 Bromfield St., Boston, 9, Mass.....408
Wilton Stellite Reversible-plug Gage. Wilton Tool Co., 2121 Grand River Ave., Detroit, Mich.....409
"Ettco" Special Self-gripping Mandrels. Eastern Tube & Tool Co., Inc., 594 Johnson Ave., Brooklyn, N. Y.....409
Standard Automatic Milling Machine. Standard Engineering Works, Pawtucket, R. I.....409
Bruce Eccentric Boring Head. Precision & Thread Grinder Mfg. Co., 1 So. 21st St., Philadelphia, Pa.....410
Ferracute Punching Press. Ferracute Machine Co., Bridgeton, N. J.....410
Reiff & Nestor Adjustable-blade Reamer. Reiff & Nestor Co., Lykens, Pa.....410
Storm Portable Reboring Machine. Storm Manufacturing Co., 406 Sixth Ave., S., Minneapolis, Minn.....411
"Strom" Double-row Radial Ball Bearings. U. S. Ball Bearing Mfg. Co., 4563 Palmer St., Chicago, Ill.....411
Waltham Thread Milling Machine with Relieving Attachment. Waltham Machine Works, Waltham, Mass.....411
LeBlond Heavy-duty Lathe. R. K. LeBlond Machine Tool Co., Cincinnati, Ohio.....412
Whiting Solenoid Brake. Whiting Corporation, Harvey, Ill..413
Sellew Adjustable Drill Head. Sellew Machine Tool Co., Pawtucket, R. I.....413

Davis & Thompson Continuous Drilling, Reaming, and Threading Machine

A HORIZONTAL type continuous multiple-spindle drilling, reaming, and threading machine has recently been developed by the Davis & Thompson Co., 251 Reed St., Milwaukee, Wis. The illustrations show this machine arranged for drilling cross-holes in automobile pistons. The production on this operation is from 300 to 400 pistons per hour, depending on the size, but production rates as high as from 1000 to 2000 pieces per hour are possible in handling small castings, pipe nipples, and similar parts, when the machine is equipped with an automatic loading attachment.

In setting up the work, the operator places the pistons on jigs which are located between two flanges as shown in Fig. 2. The flanges contain hardened steel bushings for guiding the drills, the bushings rotating with the drills so as to lessen the wear on the sharp edge of the drills. The springs that surround the drills prevent the bushings from coming out of the place during the drilling.

In the operation of this machine the spindle housings, which are shown in Fig. 3 disassembled from the machine, revolve with the work as it is carried away from the operator. It will thus be apparent that this is not an indexing machine. The spindles are moved to and fro by a cam which is located on the quill between the work-spindle and the main quill and between the housings. The ring gear seen in this illustration is bolted to the frame of the machine, and is mounted in a bearing that rotates in the same direction as the work. On the opposite end of the bearing for the pinion that engages the teeth of this ring gear is another

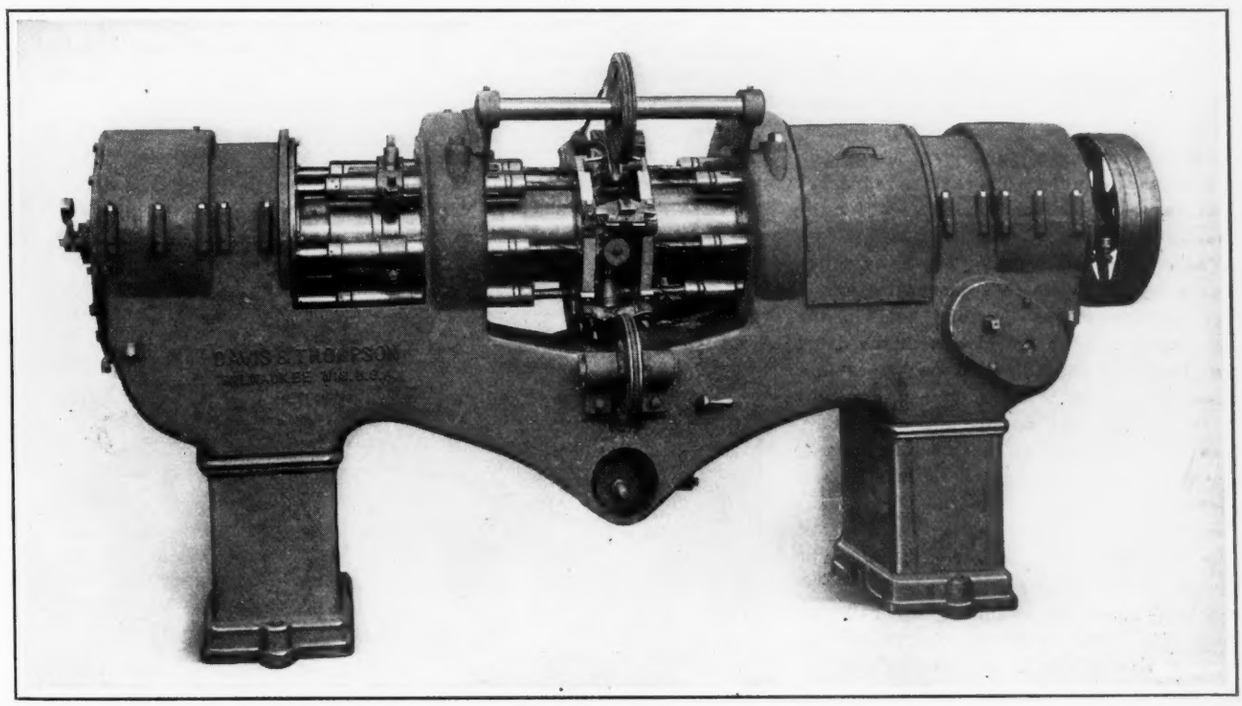


Fig. 1. Davis & Thompson Continuous Multiple-spindle Drilling, Reaming, and Threading Machine

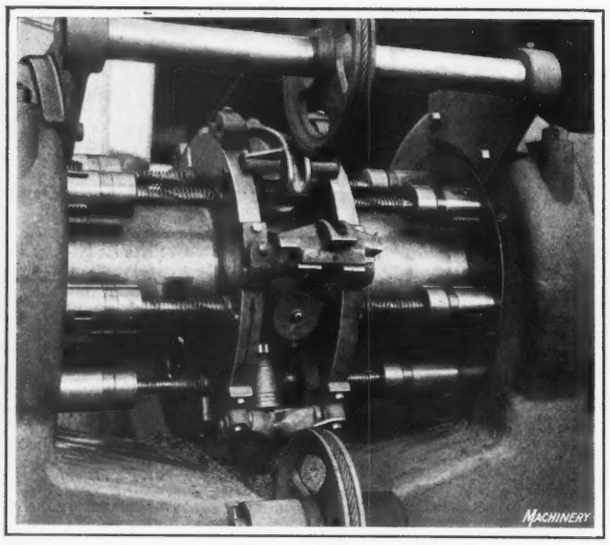


Fig. 2. Close-up View of the Work-carrier showing the Jigs, Equalizing Clamps, etc.

smaller pinion which engages a ring gear attached to the cam sleeve. The ratio between the pinion and the outer ring gear is the same as that between the smaller pinion and the cam gear, and as a consequence the cam is held stationary. A ball thrust bearing is furnished between the cam sleeve and the housing.

The driving shaft runs through the center of the machine, and from Fig. 3 it will be seen that on the left-hand end of the housing of the spindle carrier, there is a jack-in-the-box gearing. A geared pump on this end supplies oil from the reservoir through the center of the driving shaft and through the pinions in the jack-in-the-box gearing, to lubricate all internal working parts of the machine. End adjustment of the spindles to suit the length of drill and the depth of drilling is accomplished by loosening a nut on the clamp on each drill spindle, and then applying a crank on a square portion of the spindle. There is a hardened steel roller under each spindle, which rotates in the cam.

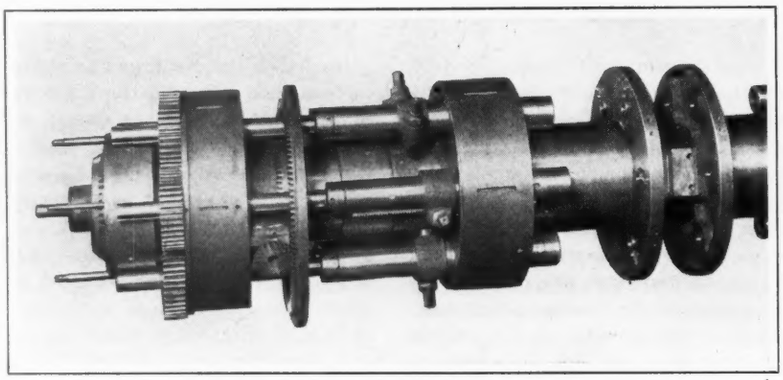


Fig. 3. Driving and Feeding Mechanism for the Spindles

The close-up view in Fig. 2 shows equalizing cable shoes which compensate for uneven surfaces of the pistons held in the jigs. As the pistons revolve with the drum and the drill spindles, these shoes are closed by a cable, bringing pressure to bear on the pistons and holding them in place. From the rear view of the machine, Fig. 4, it will be observed that there is a spring mechanism enclosed in the bed which actuates levers to maintain tension on the cable and thus compensate for variation in the size of the castings.

Pick-off gears for changing the ratio at which the work revolves relative to the speed of the driving shaft are enclosed in the cover at the right-hand end of the machine, as illustrated in Fig. 1. It will, of course, be evident that the output of this machine depends on the speed at which the twelve drill spindles and the work is revolved. When threading pipe nipples or light work, lubricant can be furnished to the cutting tools through the spindles. A water pump and pan can also be supplied. Because of the fact that work is being done through two-thirds of each machine revolution, the high production rates are obtainable without necessitating excessive speeds of the drills.

In Fig. 1 the machine is shown with a cover at one end only, but both ends are normally covered to protect the working parts from dust when the machine is in operation. Taper-shank drills up to 15 inches in length may be used. The cable arrangement for holding the work in the jigs is covered by patents.

CINCINNATI-ACME UNIVERSAL FLAT TURRET LATHE

Chuck work up to 20¾ inches swing and bar work from ¾ inch up to either 2½ or 3¼ inches in diameter, depending on the size of automatic chuck with which the machine is equipped, may be accommodated on the Cincinnati-Acme No. 2 universal flat turret lathe which is being placed on the market by the Acme Machine Tool Co., Cincinnati, Ohio. Both the flat turret and the auxiliary square turret have a cross power feed in addition to the longitudinal power feed. The square turret is intended for carrying tools to under-cut, form, face, and turn work at the same time that it is being bored or turned by tools mounted on the flat turret. All levers for controlling the rapid traverse, cross, and longitudinal power feeds and spindle speeds, binder handles, etc., have been centralized at the front of the machine. The head is cast solid with the bed to insure constant alignment of the spindle with the vees upon which the turret carriage travels.

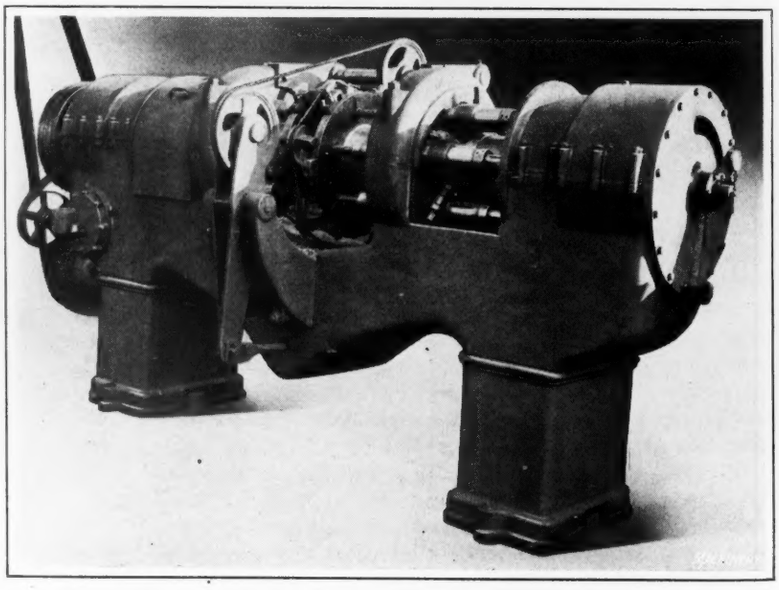


Fig. 4. Rear View of Davis & Thompson Drilling, Reaming, and Threading Machine

An all-geared head single-pulley drive supplies twelve speed changes from 18 to 318 revolutions per minute through sliding gears which are operated by means of two levers at the front of the headstock. The sliding and mating gears are made of chrome-nickel steel and heat-treated. Ample oiling of all head parts is accomplished through a splash lubricating system. The stopping and reversing lever is placed on top of the headstock and controls the operation of a friction clutch on the initial driving shaft. A hand hole in the top cover gives easy access for adjusting the friction of the clutch. A patented gear-shifting device makes it possible to change from one speed to another with one continuous movement of either of the speed-changing levers. When the lever has reached the point where one set of gears is out of mesh, the driving pulley is automatically disengaged from the friction clutch, and it is automatically re-engaged after a set of gears has been brought completely in mesh. This feature enables the gears to be shifted from one speed to another while they are revolving simply from their own momentum, thus eliminating shock and excessive clash.

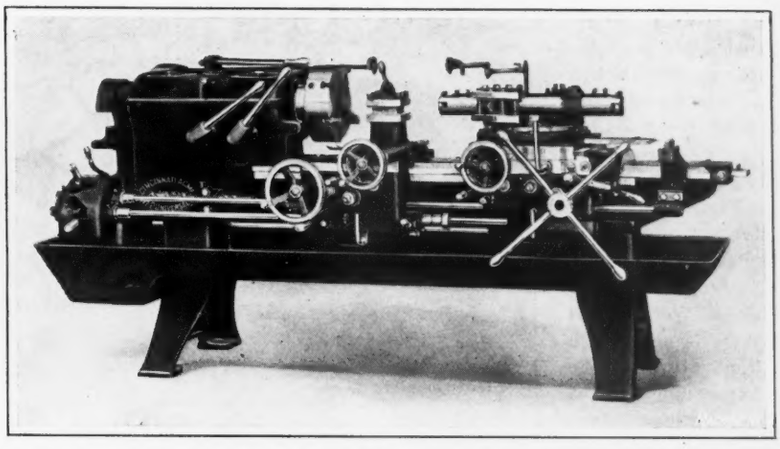


Fig. 1. Cincinnati-Acme No. 2 Universal Flat Turret Lathe arranged for Chuck Work

The side carriage is constructed to clear the chuck, and it can be moved out of the way to permit the use of short tools on the flat turret. The latter is provided with six independent stops for the longitudinal movement. The square turret can be indexed to four positions and is held in place by means of a hardened lock-bolt located directly under the cutting tool. A vertical movement of the lever on top of the square turret unclamps and withdraws the lock-bolt. The cross-slide turret revolves on a ground taper stem, and is automatically locked in position by a tool-steel taper plunger located beneath the cutting tool, which enters taper bushings near the outer edge of the turret. The turret is held down at the outer edge by circular clamps.

Cutting compound can be fed through each turret tool for deep-hole boring. The cross-slide is also provided with an adjustable hardened center stop, and it can be fed by hand or power. A power rapid traverse is furnished in both longitudinal directions for the turret, the traverse being controlled by the lever which projects vertically at the front of the carriage. The operation of this lever automatically disengages the turnstile handle, thus making a fool-proof arrangement and insuring a stationary turnstile wheel while the rapid traverse is in motion.

There are twelve longitudinal stops, one independent stop for each turret position and six auxiliary stops. As many as seven different shoulder lengths can be machined by first using the independent stop and then the auxiliary stops. The gear-box at the head end of the machine furnishes ten feeds for the power cross and longitudinal movements of both the side carriage and the turret. An oil-pump supplies ample coolant to both turret and side carriage tools when the machine is running in either direction. A five-horsepower constant-speed motor running at 1200 revolutions per minute is required for the machine. It is recommended that the motor be mounted on the rear side of the head-end leg to make the drive self-contained and compact. All machines are planed and drilled to permit convenient change from a countershaft to a motor drive at any time.

A chasing attachment is located at the right-hand end of the carriage apron. One leader is included having five threads for cutting 2½, 3½, 5, 7, 10, 30, and 42 right-hand threads per inch, but additional leaders may be supplied for other threads. Left-hand leaders are necessary for cutting left-hand threads. A taper-turning attachment can be furnished for the side carriage to permit of turning tapers up to 3 inches per foot and 12 inches in length.

The automatic chuck for bar work can be opened and closed while the machine is running by manipulating a long lever at the front of the head. Adjustments of 1/16 inch may be made to provide for variations in the diameter of work. The roller feed is simple in design and operation, only one adjustment being necessary. By adjusting the jaws to the size of stock with a spanner wrench and then slightly releasing them, the rollers will be given the proper tension. The roller feed is operated by the same lever that actuates the automatic chuck. Three roller-rest turners are furnished for bar work, and these are adjustable for any diameter of work within the capacity of the chuck.

Some of the important specifications of this machine are as follows: Maximum diameter that can be turned, 20¾ inches; swing over carriage, cross-slide, 14 inches; cross travel of turret, 7½ inches; longitudinal travel of turret, 30 inches; weight of machine with chucking equipment, 5050 pounds; and weight of machine with bar equipment, 5000 pounds.

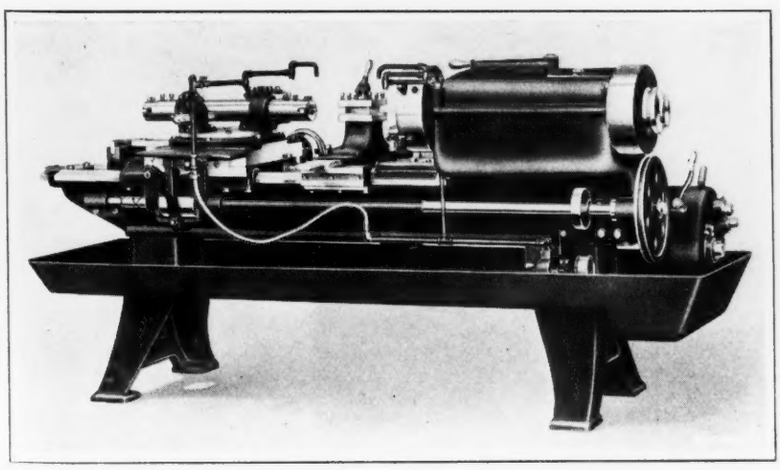


Fig. 2. Rear View of the Cincinnati-Acme Flat Turret Lathe

BADGER AUTOMATIC GRINDING MACHINES

A machine for automatically rough-grinding the parallel sides of individually cast piston-rings was described in May, 1921, MACHINERY, at the time that it was being introduced to the trade by the Badger Tool Co., Beloit, Wis. This machine is now also built for grinding other parts somewhat similar to piston-ring castings. In one instance it is being used for rough-grinding the sides of hardened steel thrust washers. With this particular equipment the grinding disks are replaced by abrasive wheels which are held in chucks, and a wet grind-

ing system is employed.

An example of how the machine is arranged for handling pieces of irregular shape is illustrated in Fig. 1, where it is shown grinding the opposite edges of automobile door hinges. Work of this nature is not passed entirely through the wheels and out at the rear, but instead is located on a reciprocating fixture bar, on the top of which is placed a suitable holder. The holder is so designed that the edges of the hinges are ground in the proper relation to the central bosses so that the male and female parts of the hinge will be interchangeable. The heads are opened and closed automatically and timed in the correct relation to the forward and backward stroke of the fixture bar, the length of which can be varied to suit conditions.

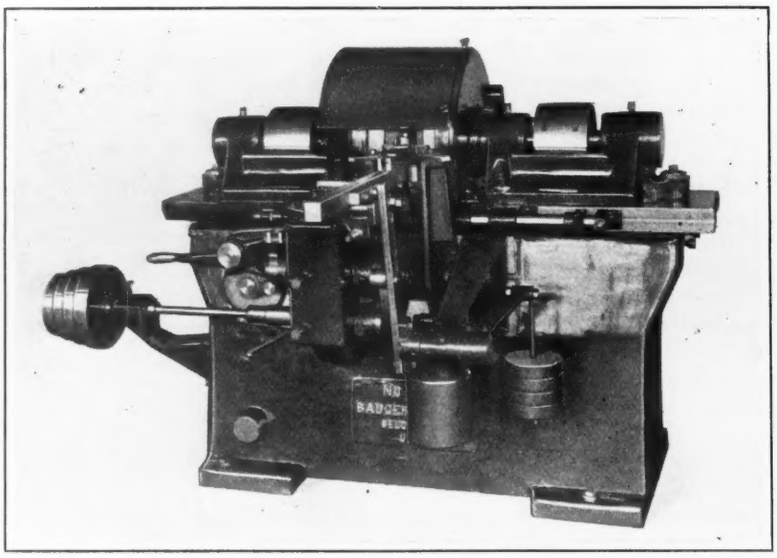


Fig. 1. Badger Automatic Grinding Machine arranged for grinding the Edges of Automobile Door Hinges

Automobile door hinges are made of various metals, most of them being either malleable-iron castings or steel forgings. Malleable-iron hinges are ground dry on abrasive cylinder wheels, while steel hinges are ground wet. Obviously, greater production rates are obtainable on the malleable-iron hinges than on those made of steel. A wheel-dressing attachment, placed at the rear of the machine, enables the wheels to be trued in about three minutes, without disturbing the setting of the machine or stopping it.

The machine illustrated in Fig. 2 is arranged for grinding coil springs to length, thus producing flat seats which are square with the axis of the coil. The springs are carried between the two grinding wheels on a revolving carrier, which has four sets of jaws, one jaw of each set being fixed and the other pivoted. As this carrying head revolves, the movable jaw opens to receive the spring, grips it while passing between the grinding wheels and then releases it, allowing the finished spring to fall down a chute. The jaws are fitted with hardened V-blocks, which are removable so that work of different diameters and lengths, can be accommodated by simply substituting different sets of blocks. The operator places the springs in the jaws as the head revolves. However, with some types and sizes of springs it is possible to load the carrier head automatically by employing a hopper or gravity feed. Most coil springs are ground wet on abrasive cylinder wheels.

The wheel-dresser of the automatic spring grinder is shown in Fig. 3 mounted on the rear of the machine. It is of the same type as is supplied on the piston-ring and hinge grinding machines, and, as previously mentioned, it takes only about three minutes to dress the wheels, and this may be done without shutting down the machine or altering the setting. As the surfaces to be ground on the work must be passed over certain parts of the grinding wheels, and as the work must travel at a predetermined rate of speed, provision is made in these machines so that the desired results can be definitely accomplished. On some classes of work it is necessary to set the wheels at a slight angle, and so the machines are designed in such a way that the wheels can be opened either at the front, back, top, or bottom. Each of the machines of the belt-driven type weighs approximately 4500 pounds.

AMERICAN KRON RIVETING HAMMER AND CONCRETE DRILL

Wear and tear on the driving mechanism and reciprocating parts is always an important factor in the design of vibratory equipment such as portable riveting hammers, due to the shock which may be transmitted to these parts as the hammer blow is struck. An outstanding feature of the portable electric riveting hammer and concrete drill, which is now being introduced on the market by the American Kron Scale Co., 430 E. 53rd St., New York City, is that

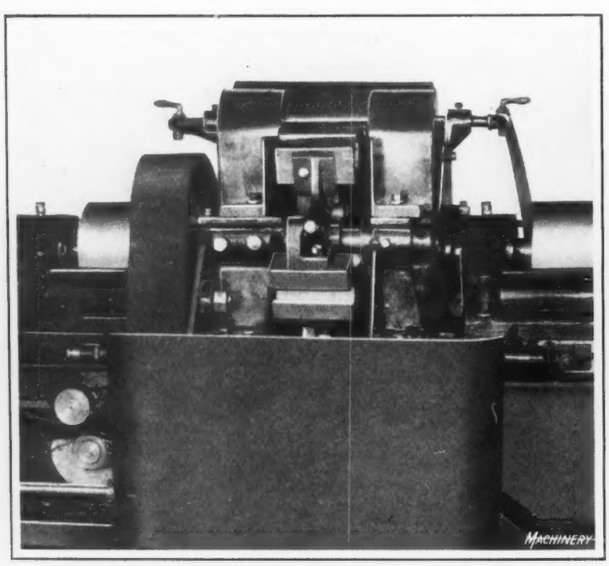


Fig. 2. Close-up View of Machine arranged for automatically grinding Coil Springs

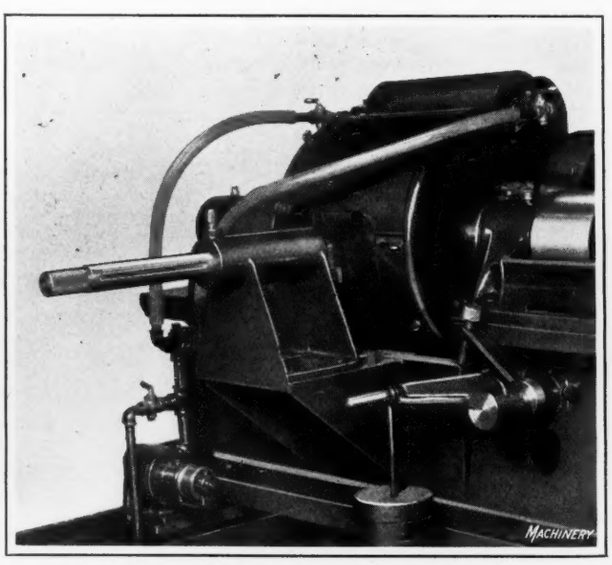


Fig. 3. Wheel-dressing Attachment at the Rear of the Spring Grinding Machine

there can be no effect on these parts from the hammer blow because the hammering member is automatically disconnected from the driving members at the moment the blow is struck. This automatic disconnection of the hammering mechanism also insures against overloading of the motor. This tool can be used advantageously for drilling concrete when installing new equipment in the shop.

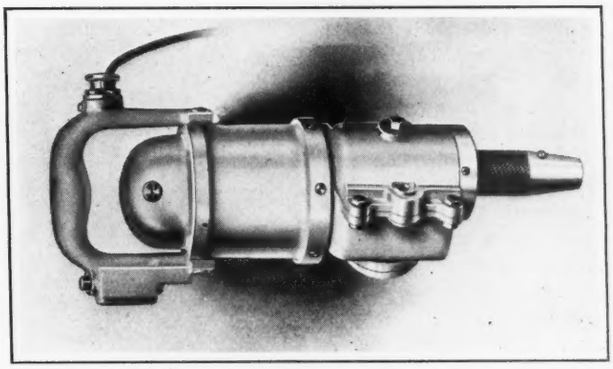


Fig. 1. American Kron Riveting Hammer and Concrete Drill

The ingenious construction of this hammer will be apparent by reference to the sectional views presented in Figs. 2 and 3. The motor is contained in the head end in a compartment into which oil cannot leak. It is cooled by a fan mounted on the armature shaft close to the bearing through which the shaft extends into the lower compartment of the body. The motor is of the G. E. universal type, operating on either alternating or direct current, has a capacity of 1/3 horsepower and runs at 6500 revolutions per minute. The motor switch is assembled in the handle, and is conveniently opened and closed by simply gripping and releasing the handle. The switch is designed for functioning with either 110- or 220-volt current.

At the lower end the armature shaft is slotted, as shown at *C*, Fig. 3, to receive the tongued end of steel worm *D*. This worm drives the bronze worm-gear *E*, the ratio being such that the speed of the worm-gear is approximately 1600 revolutions per minute. On one side of the worm-gear there is eccentrically located a pin *F*, over which is slipped the roller *G* shown at *B* lying loosely in the groove of hammer *H*. Pin *F* is contained in a hardened steel bushing in the worm-gear, so that it is free to revolve. It will be apparent that the sectional view at *B* fits over the sectional view at *A* when the hammer is assembled.

As worm-gear *E* revolves in a clockwise direction, pin *F*, with roller *G* around it operates in the groove of hammer *H* and against roller *K*, causing the hammer to reciprocate backward and forward at each revolution of the worm-gear. At the moment that the lower end of the hammer strikes the tool in the socket, the position of pin *F* and roller *G* in the groove is about as indicated at *B*, and thus the hammer, as it rebounds from the blow, has a slight longitudinal movement relative to roller *G* and pin *F*. Consequently the entire driving mechanism is free from the hammer at that instant and receives none of the shock resulting from the blow. The driving mechanism remains in operation, however, so that roller *G* and pin *F* immediately withdraw the hammer as they follow the groove to the lower end. When they reach this point pin *F* passes above the axis of the worm-gear and follows up the groove again, drawing the hammer downward for the next stroke.

Especial care was taken in the designing stage to eliminate

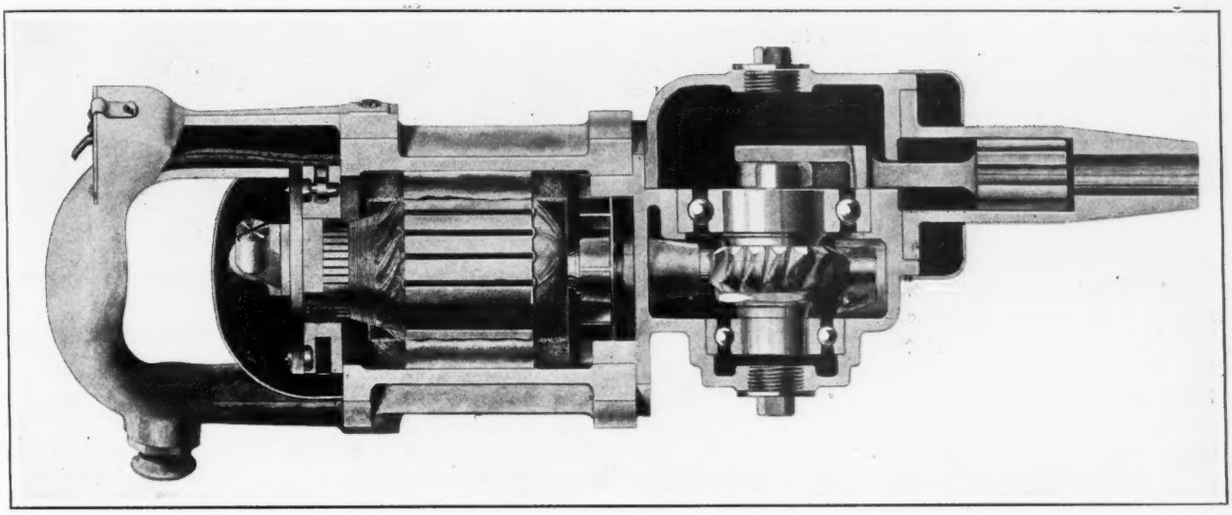


Fig. 2. Sectional View taken through the Motor and Driving Mechanism Compartments

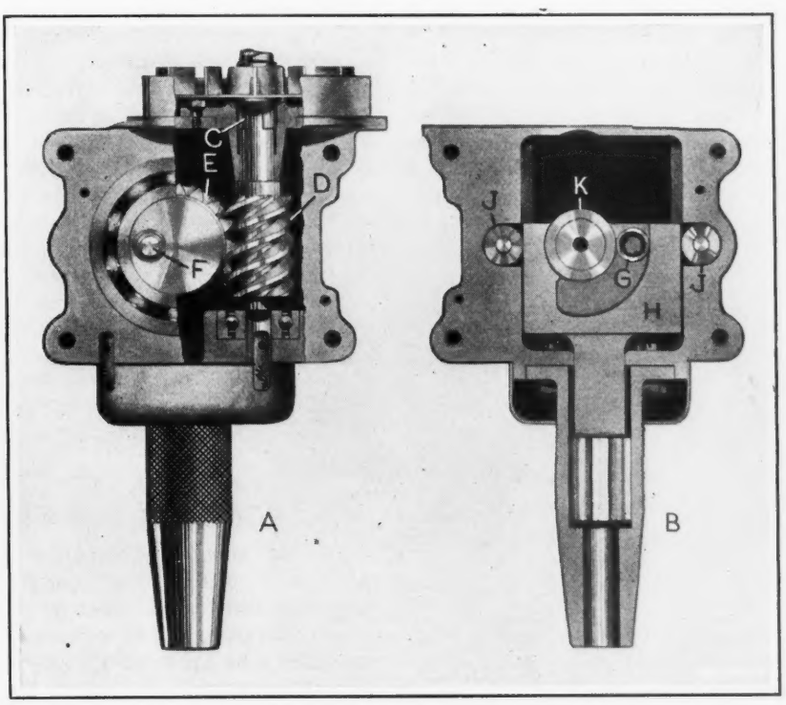


Fig. 3. Views of the Driving Mechanism and Reciprocating Hammer

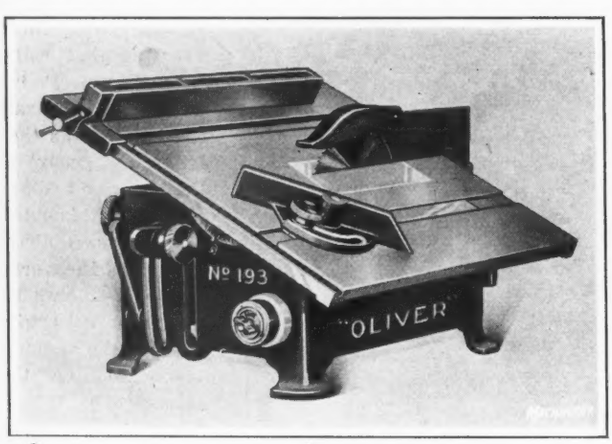
wear as far as possible. Hammer *H* reciprocates on rollers *J*, which are mounted on pins, and as there are no side thrusts, wear does not occur on the guiding surfaces of the body in which the hammer slides. Two Hess-Bright self-aligning radial ball bearings are supplied on the worm-gear shaft, and there is a thrust ball bearing for both the worm and the armature shaft. Plugs are provided in the lower compartment, so that the driving mechanism may be kept supplied with oil, it being necessary to replenish the supply only every few months. All driving parts, except the worm-gear, are made from chrome-vanadium steel, and are hardened and ground. One of the hammers has been in constant use in the shops of the manufacturer for over one year without any noticeable wear. The lower end of the hammer is grooved so that air in the socket may escape as the hammer is operated.

The size of hammer now being placed on the market has a capacity for driving up to ½-inch round-head rivets at the rate of about seven seconds per head under normal conditions. It may also be used for driving ⅝-inch rivets of the flat-head type. In operating on concrete with a 1-inch special star drill, a depth of about 6 inches per minute has been drilled: and with a 2-inch star drill, a depth of about 4 inches per minute has been drilled. In such jobs the drill is revolved slowly by means of a ratchet, so that the powdered concrete can pass more easily up along the flutes. The weight of this portable tool is 26 pounds.

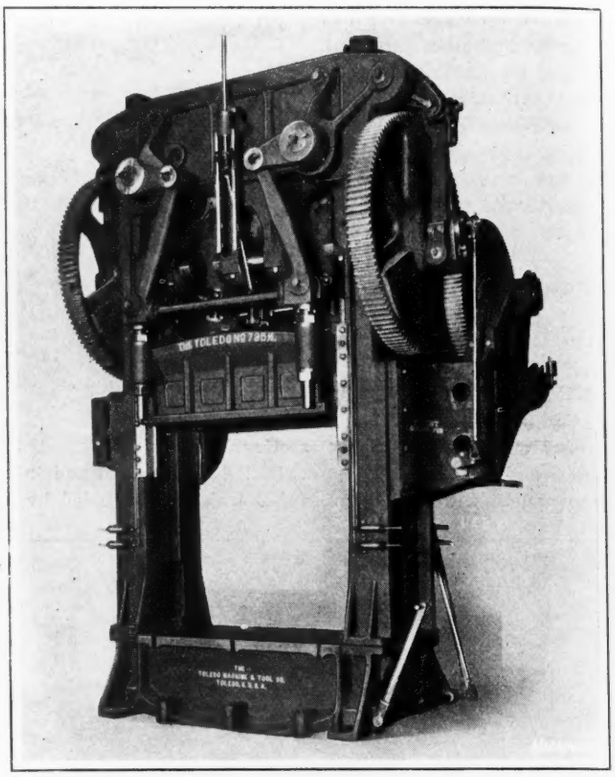
OLIVER SAW BENCH

A motor-driven saw-bench with a saw 7 inches in diameter, which cuts stock up to 2 inches thick and dadoes up to ⅜ inch in width, is being placed on the market by the Oliver Machinery Co., Grand Rapids, Mich. The motor is of ½ horsepower capacity, runs at about 1800 revolutions per minute, and, through pulleys and belting, drives the saw arbor at a speed of 5000 revolutions per minute. The equipment is portable, and can be driven from an ordinary electric light socket. The arrangement of the motor is such that the driving belt is always tight.

The table measures 21 by 24 inches, and is grooved to receive a sliding cut-off gage, which may be used on either side of the saw, set at any angle, and arranged to receive a wood face-piece when desired. The ripping gage is instantly locked in position by means of a knob. The table may be tilted to different angles up to 45 degrees, and has a graduated dial which indicates the angularity of the setting at all times. The saw guard is adjustable vertically to allow for cutting different thicknesses of stock, and is mounted on a splitter guard at the back of the table, which serves to prevent the stock from pinching the saw. The bench type of machine illustrated is 10 inches high, and when it is mounted on the floor column, with which it may be furnished, the height to the top of the table is 32 inches.



Oliver Seven-inch Self-contained Saw Bench



Toledo Double-crank Toggle Press for All Kinds of Drawing, Deep Stamping and Forming Operations

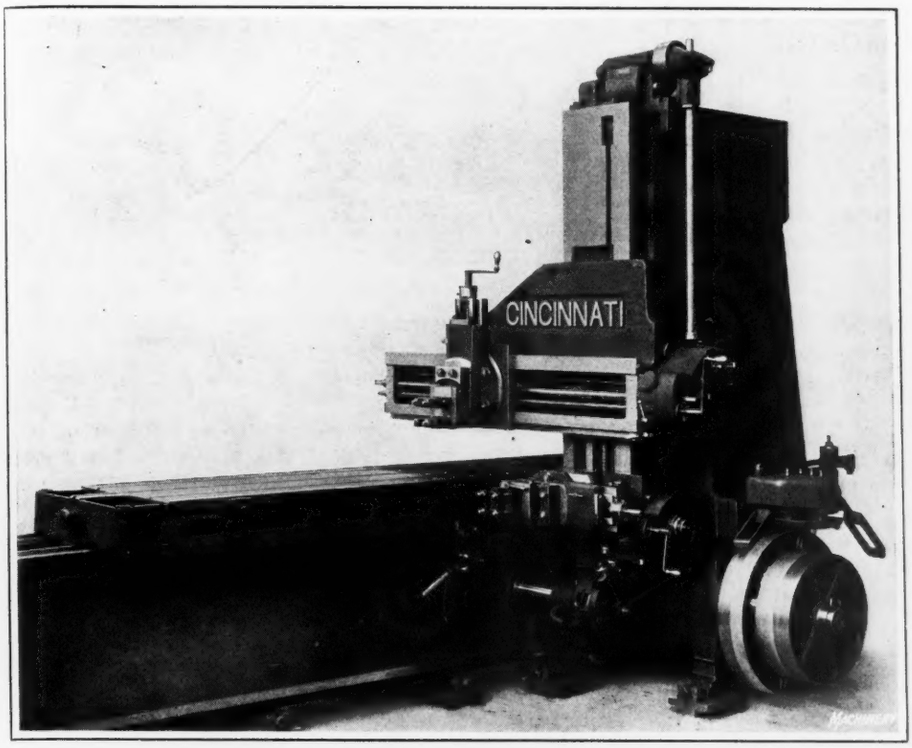
TOLEDO DOUBLE-CRANK TOGGLE PRESS

All kinds of drawing, deep stamping, and forming operations required in the manufacture of automobile bodies, cowls, fenders, engine pans, radiators, etc., and in the production of similar metal parts may be handled on the double-crank toggle drawing press here illustrated, which is built in a number of sizes by the Toledo Machine & Tool Co., Toledo, Ohio. Smooth action, accurate timing, and an absolute dwell of the blank-holder slide were among the aims of the designers in developing this machine. The drive to the crankshaft for operating the inner or drawing plunger is through twin gears at each end of the crankshaft, the teeth of the gears being machine cut.

The outer or blank-holder slide is operated by cranks which have universal connections to the twin gears on the crankshaft. Each blank-holder crank is directly connected by means of a link to a lever located at each end of the crown. The latter is of a heavy double-web cross-section, which permits running large shafts from the front to the back of the machine for carrying the levers. The levers are connected to links which control the toggle mechanism, the latter being likewise mounted on shafts which run from the front to the back of the machine. When straightened out, the toggle arms and levers transfer the blank-holder pressure directly to the frame of the press, and permit the entire power of the crankshaft to be used for the drawing operation. The press is controlled through a friction clutch of a construction that enables the operator to start or stop the machine at any point of the stroke. There is a forced-feed lubricating system to all main bearings.

CINCINNATI OPEN-SIDE PLANER

A number of improvements have been incorporated in the design of a 30- by 30-inch open-side planer which is now being introduced to the trade by the Cincinnati Planer Co., Cincinnati, Ohio. The convenience and rigidity of the design will be apparent by reference to the illustration. The table is gibbed on the operating side of the machine, so that regardless of how much overhang there is to the work,



Cincinnati 30- by 30-inch Open-side Planer of Improved Design

there is no danger of tipping the table. It also fits between the two vees in such a manner that no matter how far out from the table cuts are being taken on the work, the table cannot be twisted sideways out of the vees. For cases in which the work is much wider than the table and of considerable weight, an auxiliary table may be furnished to support the overhanging section of the work.

The bed is closed between the vees, and is cast extra heavy on the operating side, particularly at the housing cheek. This is carried up four or five inches higher than the remainder of the table so as to provide a greater surface for fastening the column. The column is ribbed thoroughly on the inside in such a way that spring is practically eliminated, and it is bolted, doweled, and tongued to the bed.

As on previous Cincinnati planers of the open-side type, the rail is mounted on a knee which is bolted directly to the column, two large T-slots being provided in the column for this purpose. Instead of using an ordinary bolt head or short nut, a sliding nut is placed in the T-slots. The construction is such that there is no possible chance of locking the knee under any condition. A gib at the front end of the knee furnishes a narrow guide bearing on the side of the column and eliminates any tendency of the rail to tip. The gib can be adjusted to obtain a sliding fit, and this adjustment cannot be changed except at the will of the operator. The rail is also gibbed at the outer end of the housing to provide a narrow guide bearing at this location, which prevents the rail from tilting or sagging even when all clamping bolts are loosened.

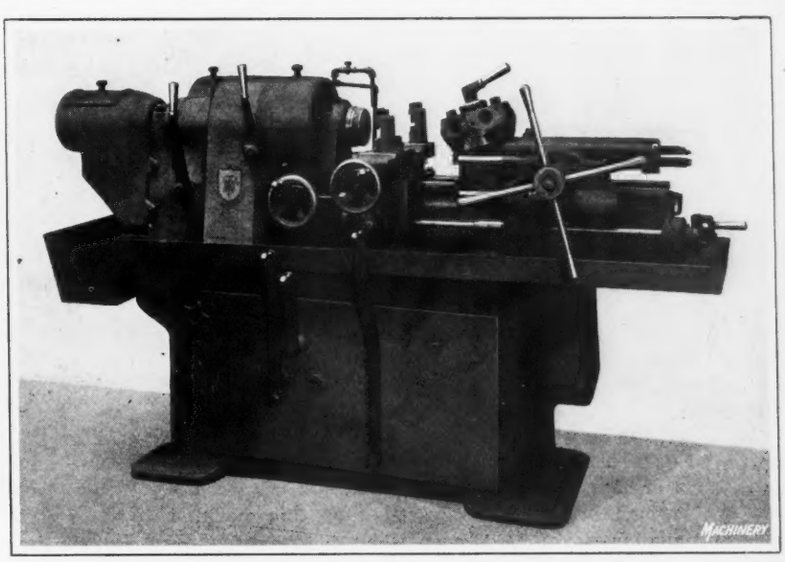
a consequent reduction in power loss and equipment expense and a conservation of space and light. The machine is mounted on a cabinet base, there being a rear cover plate inside the cabinet on which the motor is mounted. This plate is disassembled to remove the motor. A silent chain drive connects the motor with the main driving shaft at the center of the cabinet, the transmission of power being controlled through a cone friction clutch of the full-floating type.

The drive then passes through a change-gear box, which furnishes six spindle speeds on a plain head machine and twelve on a back-geared machine. Thus there are twice as many speeds as on the regular belt-driven machine, and there is the additional advantage of a reverse for every forward speed, which is accomplished through a patented device. All gears in the gear-box run in oil. From the gear-box power is delivered to the spindle through two 12-inch pulleys, between which a belt tightener is placed. All controls are centralized at the front of the machine for the convenience of the operator. The knob at the left of the base controls the belt tightener, the short hand-lever on the base controls the speed changes; and the long hand-lever controls the starting, stopping, and reversing of the machine.

Full inspection of the motor-driving unit is possible by removing the front cover of the cabinet. Air-holes in both ends of the cabinet provide an ample circulation of air for cooling the motor. The machine is said to incorporate all the best features of a geared-head single-pulley driven machine. The belt pull is in a downward direction on the headstock casting, instead of upward against the main bearing caps. All revolving parts are guarded to protect the operator and the machine. The motor is supplied for either direct or alternating current, and may be of the constant or variable-speed type. When desirable, the machine can also be driven by belt through a single pulley by mounting a jack-shaft on the rear cover plate in place of the motor.

SELF-CONTAINED TILTED TURRET LATHE

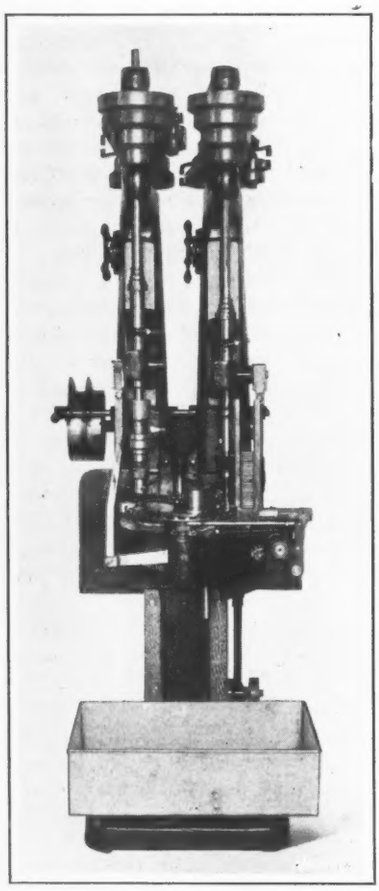
With a view to obtaining maximum convenience and economy in the installation and operation of turret lathes or screw machines, the Wood Turret Machine Co., Brazil, Ind., has developed the self-contained tilted turret machine here illustrated. All overhead shafts, hangers, pulleys and belts are eliminated, with



Wood Tilted Turret Lathe or Screw Machine arranged as a Self-contained Equipment

EDLUND DRILLING, COUNTERSINKING AND TAPPING MACHINE

The No. 2B sensitive drilling machine built by the Edlund Machinery Co., Box 57, Cortland, N. Y., has been arranged, as illustrated, for automatically drilling, countersinking, and tapping automobile fender blocks. It will be noted that the regular table has been replaced by a special fixture to which the work is fed from a magazine, so that the only labor on the part of the operator is to keep the magazine filled. The fender blocks are made of ¼- by ⅝-inch flat stock, 2 inches long, and the hole is drilled 17/64 inch deep and tapped to a 5/16-inch U. S. standard thread. Production rates up to 500 pieces per hour can be obtained with this machine. It is also adapted to a large variety of small work.



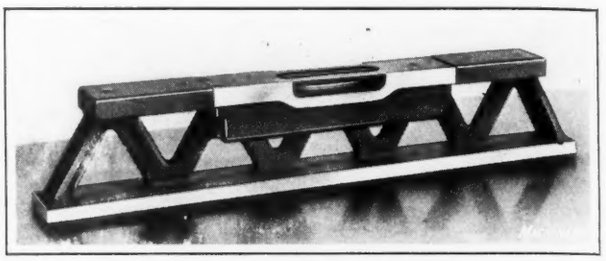
Edlund Automatic Drilling, Countersinking and Tapping Machine

The drive for all mechanisms is transmitted from the pulley shaft through miter gears. The work is fed on a plate which has several slots in it and which is indexed by means of a cam. The drilling is done with the right-hand spindle, the countersinking with an auxiliary spindle operated from beneath the work, and the tapping with a special tapping attachment used on the left-hand spindle. A stationary cam which is attached to the top plate ejects the work into a pan.

The feed for the spindles is obtained by means of racks which mesh with gears cut on the ends of the feed pinions, the racks being actuated by cams mounted on the same shaft as the indexing, locking, and feeding cams, so as to eliminate any possibility of the machine getting out of time. A generous stream of compound is supplied to the drill, countersink and tap, thereby keeping the tools and work cool, and washing all chips into a reservoir. This reservoir and guards for the cams were removed from the machine at the time the photograph was taken in order that the working parts could be more fully observed.

PRATT & WHITNEY PRECISION LEVEL

An accurate level which is especially advantageous in setting up precision machines is manufactured in different degrees of sensitiveness by the Pratt & Whitney Co., Hartford, Conn. What is known as a "10-second" level is recommended for general use. With this level, each 1/10-inch division that the bubble runs indicates a variation from the horizontal of 0.0005 inch in one foot. It has a vial ground to a radius of curvature of about 170 feet, and is as sensitive as is found practicable for setting up fine machine tools and similar work. A "3-second" level having a proportionately larger radius of curvature is more sensitive,



Pratt & Whitney Precision Level

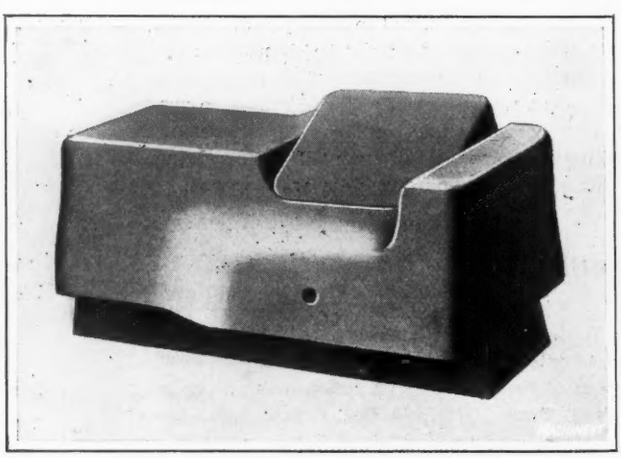
but it requires several minutes for the bubble to come to rest, and so is too sluggish for shop use.

The truss construction of the frame not only provides a level that is light, rigid and convenient to handle, but also one that is not very sensitive to changes of temperature. The frame is 15 inches long. Insulating grips are provided which prevent the heat of the hands from expanding the frame and causing errors. To check the instrument on a surface which is approximately horizontal, the level is set down, its location marked, and the position of the left end of the bubble noted, say, for example, three divisions from the center. The level is then reversed, care being taken to see that it is set in the same spot on the surface, and the position of the left end of the bubble again observed. If the reading is still three divisions from the center, the level is in proper adjustment; if the reading should differ, an adjusting screw is turned until the two readings agree. The vial carriage may be removed from the frame by withdrawing four screws.

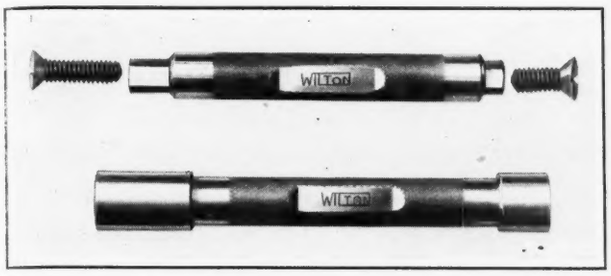
BEAUDRY TAPER HAMMER DIE

For use in forging taper work such as chisels, calking tools, railroad spikes, rocker arms, valve yokes, keys, gibs, and wrenches, Beaudry & Co., Inc., 45 Bromfield St., Boston, Mass., has brought out a new combination hammer die. This die can be furnished for any make or size of trip, air, or steam hammer, and it is said that by its use one man can draw in one heat any taper that can be produced under a hammer. As will be seen from the illustration, one end of the die is provided with a tilting face which moves freely on a fixed axis. Thus, by merely shifting the position or angle of the work and striking a light blow, the operator automatically adjusts this tilting face to the desired angular position relative to the top die of the hammer. With this construction any taper can be produced.

Scale which may happen to fall between the tilting face and the die-holder works through grooves into a pit and is forced out through a hole in each side of the holder, which insures that the tilting face will work freely at all times. The fixed plain part of the die face can be used for general forging, the same as any ordinary die.



Beaudry Tilting Hammer Die for forging Tapers



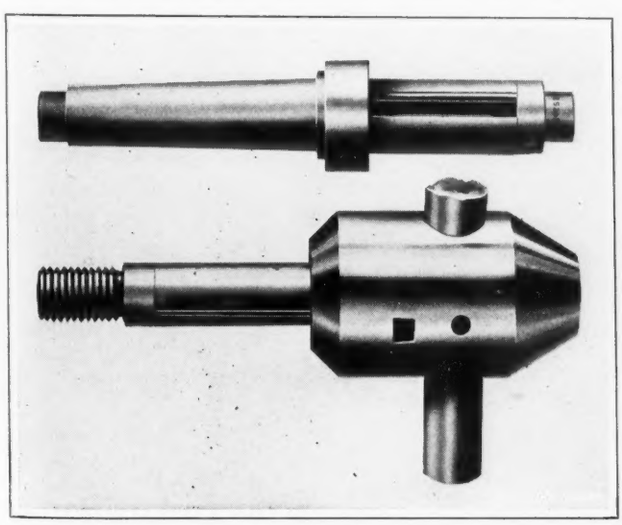
Wilton Gage with Reversible Plugs made of Stellite

WILTON REVERSIBLE-PLUG GAGE

Stellite is used for the gaging members of a "Go" and "Not Go" reversible-end plug gage manufactured by the Wilton Tool Co., 2121 Grand River Ave., Detroit, Mich. When any appreciable amount of wear has developed on these gaging members, they may be turned end for end so as to bring a new end into use. It is claimed that the stellite plugs possess from three to seven times the life of ordinary steel plugs. The handle is made from steel, as it is not subject to wear. A pilot at each end of the handle enters a hole in the corresponding gaging member. There is a flat on each pilot which coincides with a flat in the hole of the plug so as to prevent the plug from turning on the pilot. The "Go" end is made longer than the "Not Go" end so that the two ends can be readily distinguished.

"ETTCO" SELF-GRIPPING MANDRELS

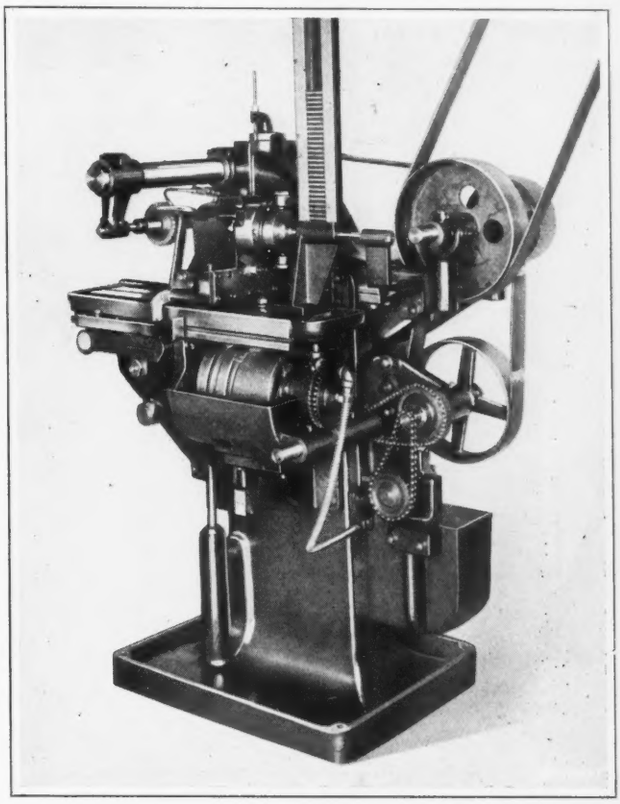
In the production of automobile parts, there are numerous instances in which it is preferable to machine the work while it is mounted on a mandrel, and it is to enable such parts to be seated on a mandrel without the application of an external force such as is usually applied by means of an arbor press, that the Eastern Tube & Tool Co., Inc., 534 Johnson Ave., Brooklyn, N. Y., have brought out the self-gripping mandrels shown in the accompanying illustration. They are also intended for use in the quantity production of bushings in plants other than those engaged in the manufacture of automobile parts. These mandrels are constructed on the same principle as the self-gripping line presented to the trade several years ago by this company. Each has a solid steel body in which there are three grooves, and each of these grooves contains a roller, made of hardened drill rod and a long flat spring that acts against the roller to hold it in the gripping position. The work is simply slipped on the mandrel, and when a cut is started, the roller automatically grips the work. The special mandrels are made to fit "Lo-Swing" and Fay automatic lathes, as well as various makes of engine lathes.



"Ettco" Special Self-gripping Mandrels

STANDARD AUTOMATIC MILLING MACHINE

High rates of production can be maintained in milling square ends of taps and other small work by the use of an automatic machine recently developed by the Standard Engineering Works, Pawtucket, R. I. As is apparent from the illustration, the work is fed from a magazine to a collet which is mechanically opened and closed. When released from the collet, the work falls on an inclined screen on the table and rolls down a chute into a box on the floor. Two cutters on the arbors straddle-mill the work, which is withdrawn from between the cutters after the first pass, automatically indexed 90 degrees, and then again traversed past



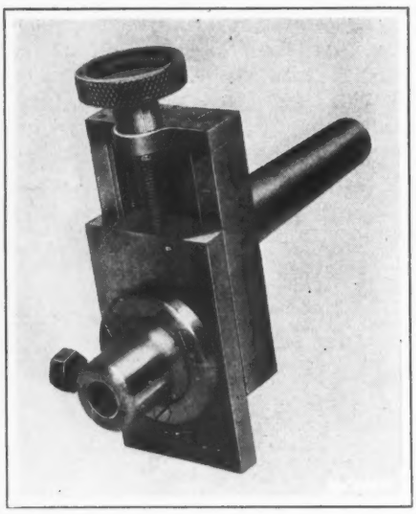
Milling Machine built by the Standard Engineering Works for milling Square Ends on Small Work

the cutters for milling the other two sides. An adjustable stop insures the cut being taken to the same length each time.

The drive is transmitted from a countershaft to the rear shaft of the machine by belt, and then to a jack-shaft directly below the rear shaft. It is next transmitted through a silent chain to worm-gearing, which drives a drum cam that moves the table as desired. The spindle is mounted in phosphor-bronze bearings provided with means for taking up wear, and it is driven by belt from the rear shaft. A crank provides for turning the machine over by hand when changing the setting to accommodate different sizes of work. Oil is supplied to the cutters from a tank located at the rear of the machine by a chain-driven geared pump. The oil drains from the table through flexible hose back to the tank, which has two compartments that are provided with a fine-mesh screen so that only clear oil is drawn into the pump. One man can operate three machines of this type, as the only labor necessary is that required to keep the magazines loaded. The normal production on ⅜-inch stock is about 500 pieces per hour per machine. The machine occupies a floor space of about 27 by 38 inches, and weighs approximately 1200 pounds. A one-size collet, countershaft, and wrenches are supplied with the machine as regular equipment.

BRUCE ECCENTRIC BORING HEAD

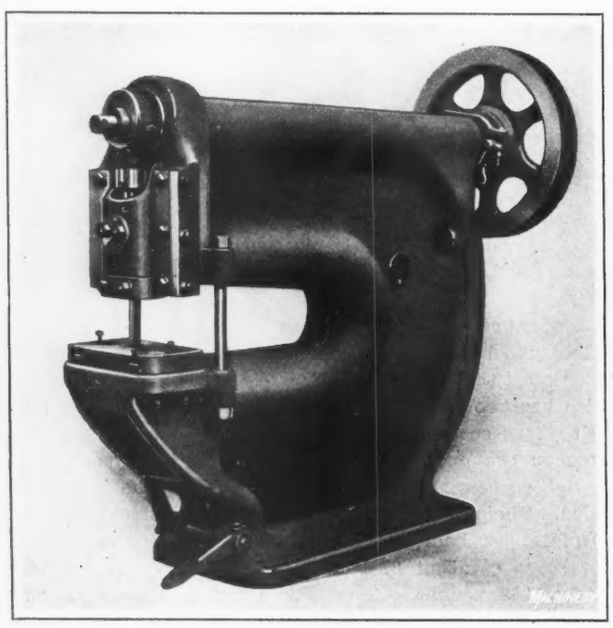
Jigs, fixtures, and similar work can be accurately bored on drilling and milling machines by the use of an eccentric head which has been added to the line of precision equipment made by the Precision & Thread Grinder Mfg. Co., 1 S. 21st St., Philadelphia, Pa. This head is especially useful in index boring operations. Wear of the sliding member is compensated for by a gib. The adjusting screw for this slide has a handle which is graduated to 0.001 inch to permit accurate settings to be readily made. The shank on the stationary member is machined to fit the spindle of the machine for which the head is intended, and the adapter on the slide takes various sizes of tools. The head is made in four sizes with respective capacities of ⅜ to 1½ inches; ½ to 2½ inches; ¾ to 4 inches; and 1 to 6 inches. Each head is supplied with a set of six boring tools, a chuck, and a test indicator.



Bruce Eccentric Boring Head for Precision Work

FERRACUTE PUNCHING PRESS

One of the features of a deep-throated punching press, which has recently been developed by the Ferracute Machine Co., Bridgeton, N. J., is the use on the driving shaft of an eccentric which may be simply changed in order to alter the stroke of the reciprocating members. Besides this advantage, the construction also permits the shaft to be almost the full diameter where it projects from the front bearing. The eccentric is fitted on a taper bearing, and is held in place by means of a large nut; it is driven through a feather in the tapered portion of the shaft. The design permits the shaft to be quickly assembled and disassembled without withdrawing keys. The machine is designed to exert a pressure of 35 tons, and will shear ⅜- by 5-inch flat iron or soft steel, punch a 1-inch hole through 7/16-inch metal, or cut off 1⅛-inch round bar stock. It is known as the "P-43."



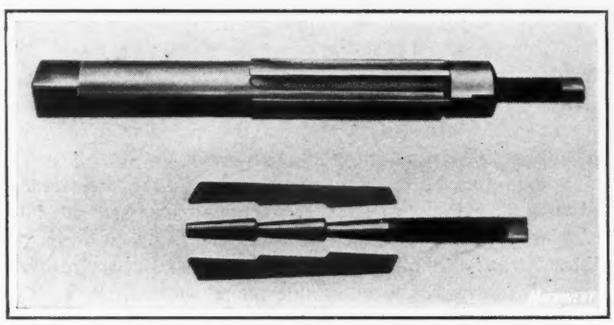
Ferracute Punching Press of 35-ton Capacity

The shaft is 3½ inches in diameter, and has a large collar forged to it, in which the clutch mechanism is mounted and which serves as a brake wheel. The ram is guided between two gibs to facilitate making adjustments to compensate for wear. The pitman contains a pivot so mounted in the ram that a large bearing surface of solid metal is obtained. The pitman stem is gripped by a telescopic nut, which is made in halves, clamped together by means of large bolts.

The stay-rods shown in place on the machine prevent any tendency to spring when the press is being worked to the limit of its capacity, but they are said to be really unnecessary from the standpoint of strength. A motor shelf may be attached to the back of the frame. Some of the principal specifications of this machine are as follows: Stroke, 1½ inches; ram adjustment, 3 inches; depth of throat, 42 inches; flywheel diameter, face, and weight, 35 inches, 6 inches, and 700 pounds, respectively; over-all height, 7 feet; and approximate weight, 5350 pounds.

REIFF & NESTOR ADJUSTABLE-BLADE REAMER

One of a line of adjustable-blade reamers now being offered to the automobile and general machine building and repair fields, by the Reiff & Nestor Co., Lykens, Pa., under the trade name of "Maxpan" is here illustrated. The smaller sizes of this reamer have an expansion of 1/16 inch, and the larger sizes ¼ inch; there is practically no lateral travel of the blades in the body when an adjustment is made. The central adjusting screw has three conical surfaces which contact with correspondingly tapered steps on the reamer blades, and thus a forward adjustment of the screw, after the single binding nut has been loosened, causes the reamer blades to expand radially.



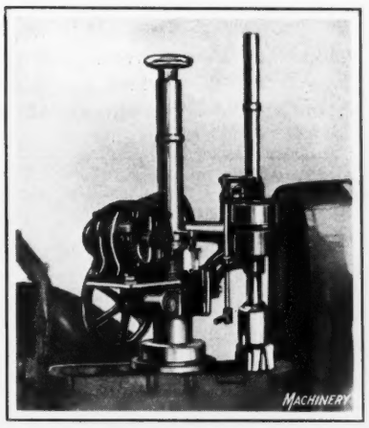
"Maxpan" Adjustable-blade Reamer

Both ends of each blade are finished at an angle with the cutting edge, and when the blade is assembled in the body, one end contacts with a similar angular surface on the slot in which the blade happens to be placed, while the other end contacts with a beveled annular groove in the binding nut. The blades are not only held firmly in place by this method of assembly, but they are also pressed radially inward and seated rigidly on the central adjusting screw. The reamer is made in fourteen sizes, ranging from ½ to 2 9/16 inches in diameter, and is provided with from six to eight blades, according to the size.

The body is made of tool steel; the binding nut is made of high-carbon steel and hardened; the adjusting screw is of tool steel and hardened and ground; and the blades of a special alloy steel. The design of the reamer is changed slightly and a shank added when the tool is to be used in a machine.

STORM PORTABLE REBORING MACHINE

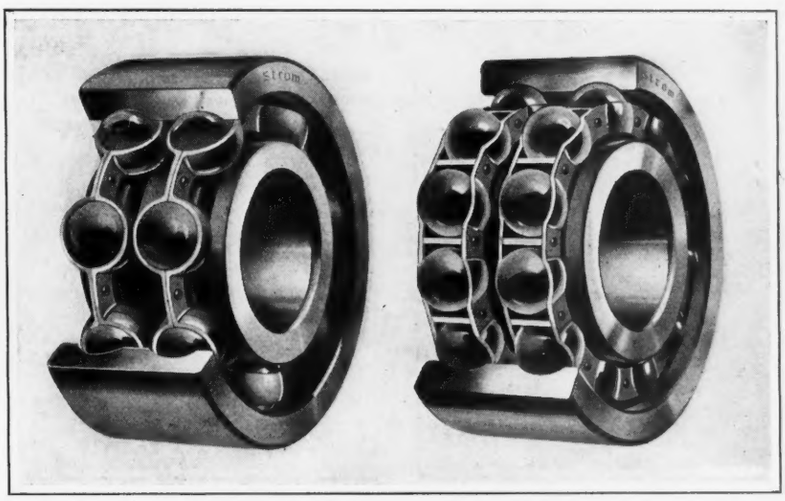
Reboring automobile cylinders without removing the cylinder block from the chassis may be accomplished by means of the Model S portable machine which is now being introduced to the trade by the Storm Mfg. Co., 406 Sixth Ave., S., Minneapolis, Minn. This machine is clamped on top of the cylinder block by means of a bolt and yoke, after the cylinder head and pistons have been removed. The bolt is dropped through the cylinder, and as this is done, a swivel cross-member on the bolt automatically catches fast. The main bearings for supporting the boring-bar are cast integral with the body casting to insure perfect alignment of the various machine members. Adjustment of the bearings is possible through split taper bushings and adjustable collars. Storm patented cutter-heads are used on this machine, but, while they embody the same principle as the cutters used on heavier machines built by this company, they are not interchangeable with those heads. The motor drive is standard, but the machine can also be so arranged as to derive its power from an electric drill.



Storm Reboring Machine

"STROM" DOUBLE-ROW RADIAL BALL BEARINGS

Double-row radial ball bearings of the types illustrated have been added to the line of "Strom" bearings manufactured by the U. S. Ball Bearing Mfg. Co., 4563 Palmer St., Chicago, Ill. These double-row bearings are known as "standard" and "maximum," respectively. The "maximum" bearings have 25 per cent greater capacity than the "standard" bearings of the same size, and for both types the permissible thrust load is 25 per cent of the available radial capacity. Special attention is called to the retainer construction of these bearings, two independent riveted retainers being provided, one for each row of balls. The new bearings are designed to carry heavy radial loads, but they are also capable of supporting thrust loads. They are especially adapted for installations requiring unusual bearing capacity in a limited amount of space.



Two New Types of "Strom" Radial Ball Bearings

RELIEVING ATTACHMENT FOR WALTHAM MILLER

To provide for relieving taps, hobs, and milling cutters, the Waltham Machine Works, Newton St., Waltham, Mass., are now prepared to furnish the thread milling machine of their manufacture with a compound taper attachment to replace the standard taper attachment regularly supplied with the machine. The compound taper attachment is arranged to travel forward and backward, being actuated by a cam through levers which may be adjusted to give the desired amount of relief to the work. The cam makes one revolution for each flute, and it can be cut for milling either concentrically, with ordinary reliefs, or with a combination of both.

In order to use the gearing necessary for operating the relieving attachment, according to the required number of flutes, a special driving mechanism is attached to the top of the work-head. There are two starting levers, one of which is used when relieving operations are being performed, and the other for ordinary threading operations. These levers are so arranged that when one is being employed, the other is locked. The compound taper attachment can be used for machining plain tapers in either direction, for straight milling, and for a combination of straight and taper milling. The change from the straight to the taper can be made automatically at any predetermined point. Spiral-fluted as well as straight-fluted work, and multiple threads as well as single threads may be relieved.

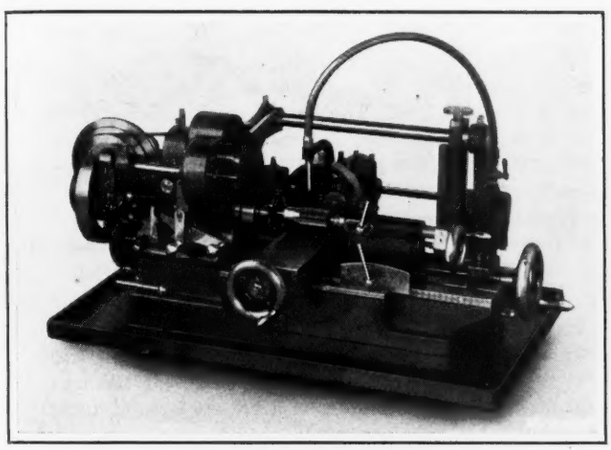


Fig. 1. Waltham Thread Milling Machine arranged for relieving Taps, Hobs, and Cutters

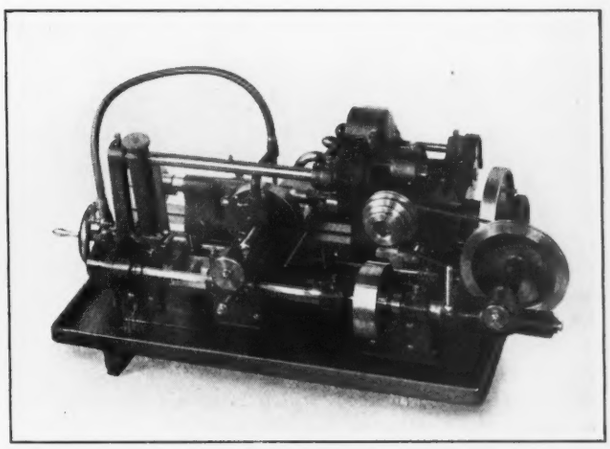


Fig. 2. Rear View of the Waltham Thread Milling Machine illustrated in Fig. 1

LE BLOND HEAVY-DUTY LATHE

A heavy-duty single-pulley-driven geared-head engine lathe is being placed on the market in two sizes, 25- and 27-inch, by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio.

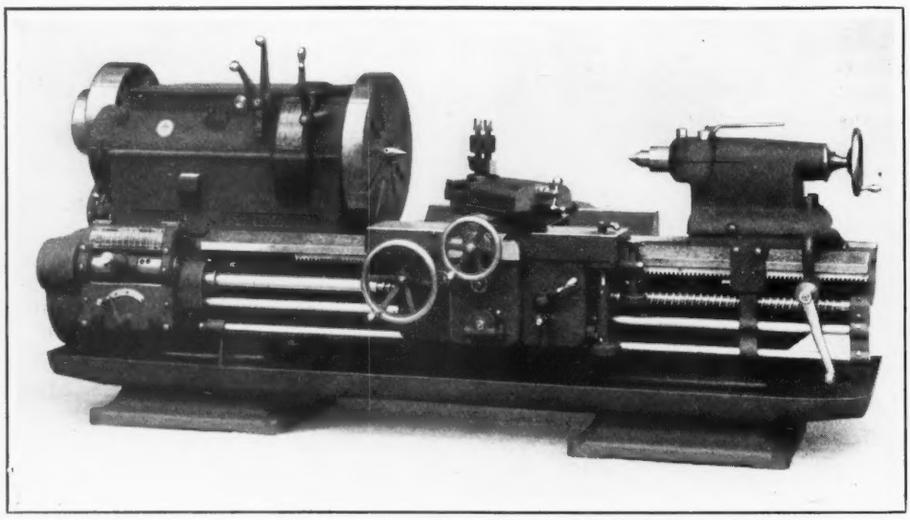


Fig. 1. LeBlond Heavy-duty Single-pulley Geared-head Engine Lathe

The geared headstock furnishes sixteen selective speeds, and drives through a multiple-disk clutch. The lathe also embodies an improved change-gear mechanism and a one-piece box-section apron having a positive-jaw feeding clutch. The various spindle speeds are obtained by manipulating two levers on the headstock, and any speed may be immediately selected. The sliding gears are made of a nickel steel alloy and are heat-treated. The teeth are of stub form, rounded to permit easy engagement. The driving clutch may be operated by a lever at the front of the headstock and by a lever on the carriage. The latter feature provides for starting and stopping the spindle with the carriage at any position along the bed, which is invaluable on a long-bed lathe. Upon releasing the driving clutch, the lever also applies a friction brake to stop the spindle instantly. The headstock is kept flooded with oil from a submerged pump.

The bed has what is known as an "improved compensating vee." With this construction the back of the carriage travels on a flat surface, while the front slides on a guide which is approximately V-shaped, one side being machined at an angle of 15 degrees, and the other at an angle of 70 degrees. The 15-degree angular surface presents a thrust bearing at right angles to the resultant pressure on the tool, and automatically compensates for wear of both the carriage and bed. All tendency of the carriage to climb under heavy cuts is said to be eliminated by this vee construction.

The apron is of a patented construction in which both feeds are actuated by means of a single positive-jaw clutch. The feed is tripped in or out of mesh by a lever at the front of the apron, and the change from a horizontal to a cross feed, or vice versa, is accomplished by means of a sliding gear transmission operated through a knob which is located just above the feed clutch. When this device is set to a central position, all gears are disengaged. The compound-rest swivel is graduated in degrees for angular turning and taper boring, and adjustable taper gibs are provided to compensate for wear on all sliding surfaces. The collar on the top slide screw is graduated to thousandths of an inch.

The carriage is accurately held on the bed by means of adjustable gibs, and a drop-forged clamp provides for locking it in position for facing operations. This clamp is tightened and loosened through a bolt, the hexagonal head of which is on the top of the carriage. The tailstock is held in alignment with the headstock by a vee at the rear, the front of the tailstock sliding on a flat surface. A tongue on the base of the tailstock fits a groove in the top member to keep the spindle in alignment with the headstock spindle. The tailstock is moved along the bed by a rack and pinion.

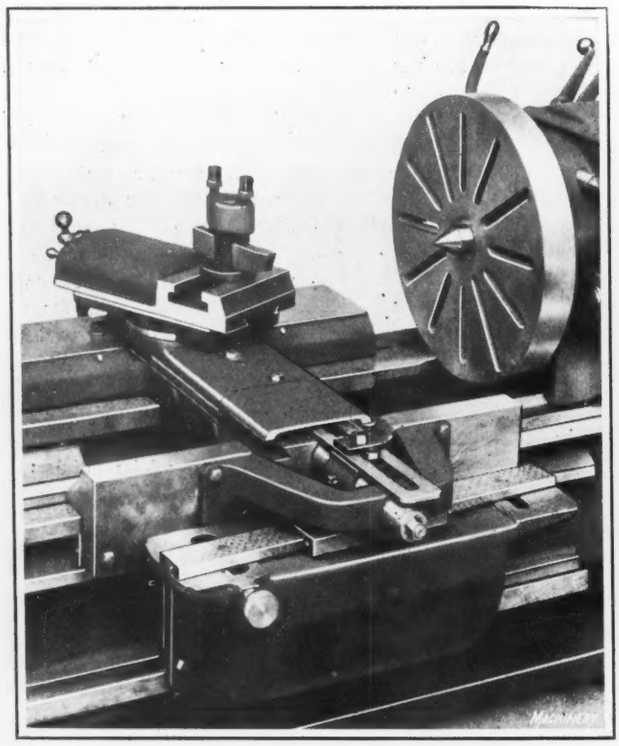


Fig. 2. Close View of the Taper Attachment and Carriage from the Rear of the Bed

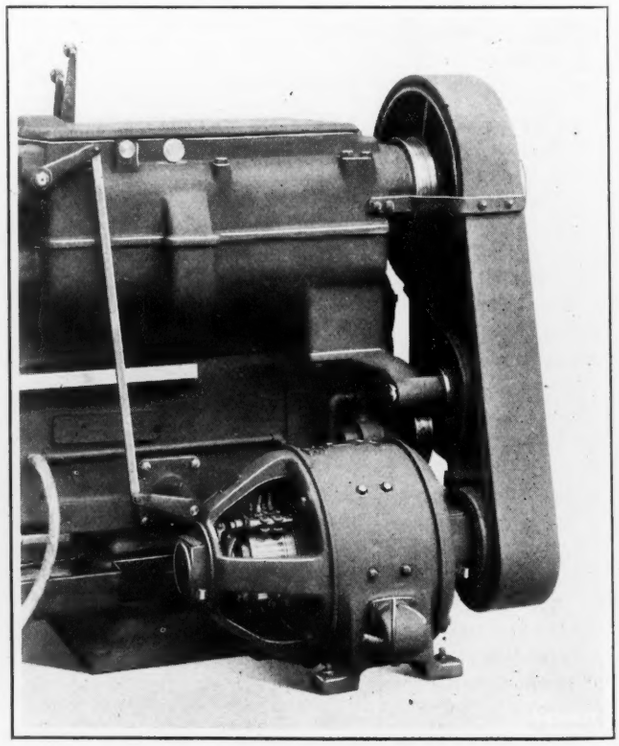


Fig. 3. Location of the Motor when the Drive is by Belt from a Constant-speed Motor

The quick-change gear mechanism is of the same general construction as has been supplied on LeBlond lathes for a number of years, but it has been improved and is of a heavier design. The range of threads and feeds has been selected to cover the usual requirements, the threads being forty-eight in number and ranging from ¾ to 46 threads per inch. A quick-change gear-box, arranged to provide for cutting a full commercial range of metric threads, may also be furnished, in which case the lead-, cross-feed and compound-rest screws have the threads cut according to the metric system. The lead-screw thread is regularly of special U. S. standard form, 1-inch pitch and 2 3/16 inches in diameter. A chasing dial provides for catching any thread without reversing the lead-screw.

The taper attachment is mounted on a bracket at the rear of the bed, as illustrated in Fig. 2, and may be moved to any position along this member. The guide bar is adjusted to suit the desired taper by means of a knob and graduations on the end of the bar. A steel draw-bar is provided for continuous heavy taper turning and boring operations, thus relieving the cross-feed screw of all strains.

Arrangements of Motor Drive

Three types of motor drive are furnished: A belted drive for constant-speed motors, either alternating or direct current; a constant-speed geared drive, for either alternating or direct current; and a variable-speed drive for direct-current variable-speed motors. In the belted drive, the motor is mounted on a hinged plate attached to the base of the lathe, as illustrated in Fig. 3, and a belt tightener pulley mounted on Hyatt roller bearings serves to increase the contact area of the belt on the motor and driving pulleys.

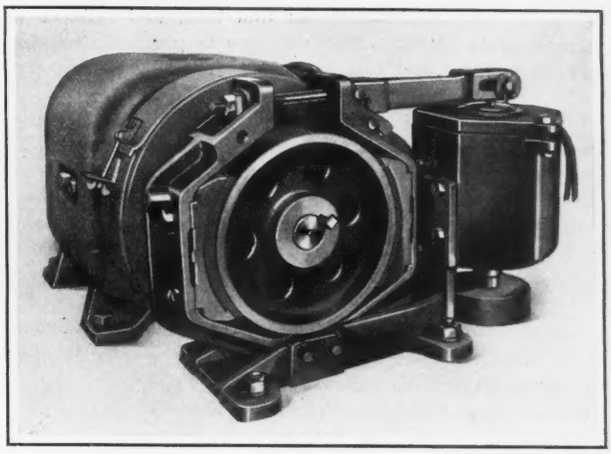
In the constant-speed geared drive, the motor is mounted on the top of the headstock and drives through a pinion and intermediate gear to a wide-faced gear substituted for the driving pulley. With direct-current motors an electrical control may replace the mechanical one on the apron. With alternating-current motors on which dynamic-brake controllers cannot be obtained, the spindle is controlled mechanically. However, it may be controlled electrically if the motor has a reversing control on which the first point of reverse is used for a brake. In the variable-speed geared drive, the motor is also mounted on the headstock and an electrical control is supplied. For constant-speed drives, a 15-horsepower motor running at 1750 revolutions per minute is recommended, and for a variable-speed drive, a motor of the same horsepower capacity, running at from 500 to 1500 revolutions per minute.

Specifications

Some of the principal specifications of this lathe are as follows: Swing over shears, 27½ inches on the 25-inch lathe, and 29½ inches on the 27-inch lathe; swing over carriage, 18¼ inches on the 25-inch lathe, and 20¾ inches on the 27-inch lathe; distance between centers on the 25-inch lathe with a 12-foot bed, 5 feet 9 inches, and on the 27-inch lathe, 5 feet 7 inches; range of spindle speeds, 8 to 300 revolutions per minute; range of feeds, 0.003 to 0.184 inch per revolution; approximate weight of a 25-inch lathe with a 12-foot bed, 10,100 pounds, and of a 27-inch lathe (12-foot bed), 10,520 pounds.

WHITING SOLENOID BRAKE

A quick-acting solenoid brake known as the Type C, which is designed especially for crane and other severe service, is now being manufactured by the Whiting Corporation, Harvey, Ill. The brake arms are so pivoted that the shoes release equally at all points, and thus eliminate any chance of their dragging at the lower end. The shoes are iron castings, while all parts subjected to stress are made of cast steel. The shoes are filled with asbestos composition which has been tested to be durable and heat resisting. In replacing a shoe, it is only necessary to remove four cap-screws and slide the shoe out.

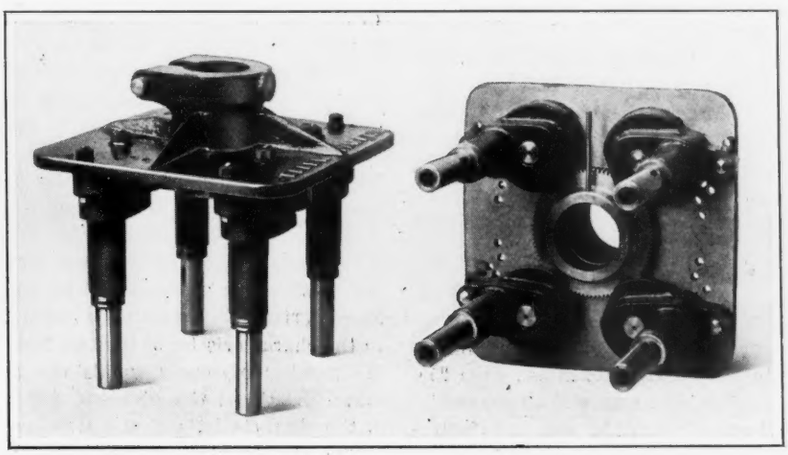


Whiting Solenoid Brake for Cranes and Other Severe Service

On direct-current brakes the plunger is a piece of soft iron of large diameter, which gives a fast-operating solenoid even at light loads. The direct-current coil is designed to operate the brake at about 40 per cent of the full-load current and remain open at 10 per cent or less of the full-load current. The plunger on the alternating-current brake is made of laminated iron.

SELLEW ADJUSTABLE DRILL HEAD

An adjustable drill head on which the spindles can be set quickly and accurately, and positively locked in a predetermined position relative to each other, within a certain range, is being brought out by the Sellew Machine Tool Co., Pawtucket, R. I. The spindles of this head are held in position by means of two bolts, one of which is removable so that it can be inserted in the proper hole for the desired set-up. It is by this method that the correct locating and positive locking is assured. The head illustrated is intended for drilling six different sets of four holes each, at the corners of different sized rectangular parts, such as the feet of small motor frames that are produced in small lots, and require frequent resetting of the spindles. The body of the head is attached to the drilling machine quill with the central driving gear on the outside of the spindle nose, thus reducing the overhang of the auxiliary spindles to the minimum. The head is manufactured in several different sizes.



Sellew Adjustable Drill Head on which the Spindles may be quickly positioned

NEW MACHINERY AND TOOLS NOTES

Bench Drilling Machine: Joseph W. Jones, 29 W. 35th St., New York City. A bench drilling machine having a capacity for drilling holes up to ¼ inch through steel. The spindle motor is started and stopped automatically when the operator manipulates a handle to feed or elevate the spindle. This eliminates wear and tear, and reduces the current consumption. The machine is portable, weighing only 18 pounds, and can be driven from an electric light socket.

Wrenchless Chuck: Thomas Elevator Co., 24 S. Hoyne Ave., Chicago, Ill. Several changes have been made in the construction of the Barker wrenchless chuck, including a redesigned cam mechanism which gives greater strength and increased travel of the jaw. This makes it possible to handle a wider range of irregular work. In the smaller sizes, trunnion arms are eliminated by using a box cam, while in the larger sizes the arms have been redesigned to obtain greater strength and a wider range of movement. These changes make it possible to apply a long leverage without damaging the chuck.

Butt-welding Machine: Thomson Electric Welding Co., Lynn, Mass. A line of butt-welding machines especially adapted for making flash welds. In the smaller sizes pressure is applied to a movable slide by a toggle mechanism which provides a wide range of adjustment for the movable slide and enables the operator to apply the maximum welding pressure at the moment the toggle straightens out. In the larger sizes, the pressure is applied by hydraulic cylinders. The transformers are of the open type and of ample cross-section to carry all normal currents without resistance heating; they are also air-cooled.

* * *

TELLING HALF-TRUTHS TO ESCAPE OBLIGATIONS

By CHARLES W. LEE

Some wise person has said, "A little truth like a little learning is a dangerous thing," which reminds me that once upon a time when I was running a small toolmaking shop I received an order one day from a concern about fifty miles away for some tools to make an article, a sample of which came with the order. After two or three months of unsuccessful attempts to collect the bill for the tools, they were returned with the information that "they didn't work." Later, I learned, from a man who had worked for the concern fifty miles away, that the idea of making the article for which the tools were ordered was abandoned before the tools had ever been put to work.

And right here is where the little truth or the half-truth comes in. As the article was never made, the tools certainly did not work, and this little truth certainly was a dangerous thing to me to the extent of the amount of the uncollected bill.

Of course, such practices as these may be termed by some "lack of common honesty," and they are; the sooner the machine shop industries can be freed from concerns who conduct business on this basis, the better. If it were possible to arouse the builders of machinery and tools to common action in combating trade abuses, as referred to on page 228 of November MACHINERY, something might be accomplished that would discourage those who are not willing to fill their obligations.

* * *

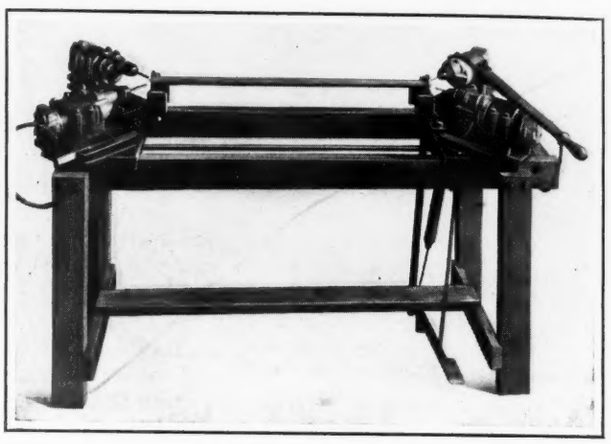
CORRECTION

In the foot-note accompanying the article "Simmons Method of Hob Making" in December MACHINERY, page 255, the address of the National Tool Co. was given incorrectly. The note should have read as follows: All the manufacturing rights of the Simmons Method-Hob Co. have been acquired by the National Tool Co., Cleveland, Ohio.

DRILLING HOLES IN SPOOL HEADS

A machine comprising four portable electric drills mounted on a stand for simultaneously drilling four holes angularly in the heads of textile spools or bobbins, wire spools, etc. is shown in the accompanying illustration. These holes receive wooden dowel-pins for holding the heads to the center or body, and insure against the heads unscrewing or loosening. A spool which measures 35 inches between the heads is shown ready for the drilling operation.

The electric drills are of standard make, and each is mounted on an adjustable base with the center line of the spindle at an angle with the center line of the spool. The spindles may be fed either by hand or foot, or by both, as the actuating levers are connected. The motion is transmitted to all four drills through a splined shaft, rack, and pinion. The right-hand drilling unit can be adjusted to any point along the ways of the stand to accommodate spools of various lengths. The work is simply held in vees by the operator, as there is no tendency for it to turn or shift. The vees are adjustable vertically to suit different diameters of spools. The machine was built by Mulliner Bros., 445 S. Warren St., Syracuse, N. Y., for a textile machine manufacturing concern.



Machine for simultaneously drilling Four Holes in Each Head of Spools

* * *

LOCATING THE DECIMAL POINT IN SLIDE-RULE CALCULATIONS

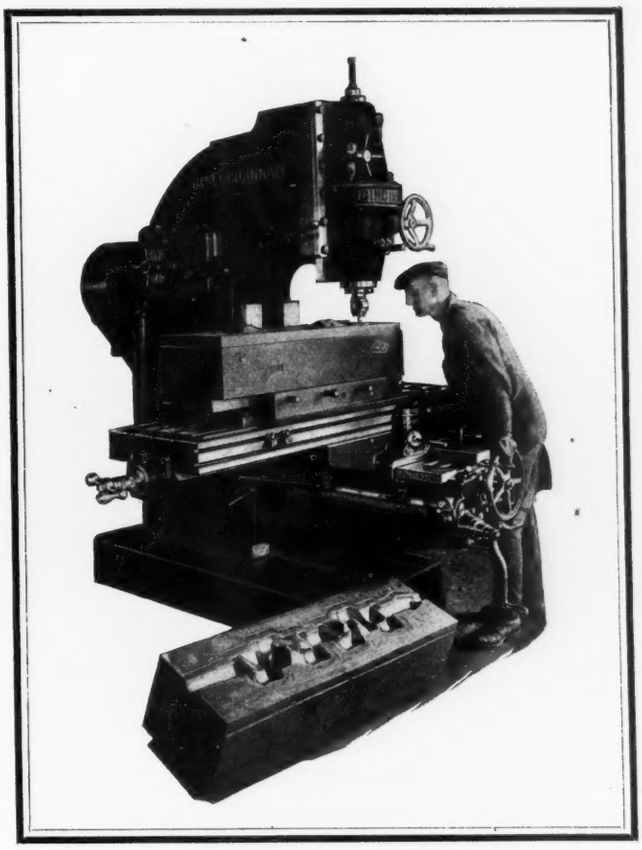
By HENRY R. BOWMAN

Many users of slide-rules have difficulty in memorizing the rules for pointing off the correct number of places. This difficulty may be overcome by simply marking the ends of the slide-rule. With a sharp-pointed scribe, mark the right-hand end of the D scale with the notation $\times$—1 and under this mark $\div$ + 1. These characters or notations indicate that in multiplying, if the slide projects to the right, the number of digits in the characteristic of the result is equal to the sum of the digits in the characteristics of the two factors less one; and that in division, if the slide projects to the right, the number of digits in the characteristic of the quotient equals the number of digits in the characteristic of the dividend minus the number of digits in the characteristic of the divisor plus one.

If desired, the left-hand end of the D scale can be marked $\times$ + and $\div$ —, to indicate that when the slide projects to the left in multiplication, the number of digits in the characteristic of the result is equal to the sum of the digits in the characteristics of the two factors, and that in division, the number of places equals the number of digits in the characteristic of the dividend minus the number of digits in the characteristic of the divisor.

The simple plan outlined will aid in overcoming this trouble so often met with in the operation of the slide-rule.

CINCINNATI MILLERS



CINCINNATI No. 4 VERTICAL

DIE SINKING

Complete control from one position enables the operator to handle heavy dies with ease.

The convenient location of the power feed control levers (cross, vertical and longitudinal) encourages the operator to use the *power* feeds for roughing out the die. The right feed for any given cut is obtained through the movement of a single lever, without changing position.

An auxiliary hand wheel at the front of the saddle for the longitudinal table feed, is convenient when hand profiling.

And the spindle head can be instantly adjusted vertically.

For the long table adjustments the power quick traverse is used.

Have our Specialist make a study of your work

THE CINCINNATI MILLING MACHINE CO., Cincinnati, Ohio

PERSONALS

GEORGE U. HATCH has been elected vice-president in charge of sales of the Millers Falls Co., 210 River St., Millers Falls, Mass.

FINLEY L. WALTON has been appointed general sales manager of the Drop Forge Division of the Union Switch & Signal Co., Swissvale, Pa.

A. A. HELLER has taken over the management of the International Oxygen Co., Newark, N. J., succeeding L. W. Hench, formerly secretary and general manager.

A. E. JONES, who has been sales engineer in the New York office of the Terry Steam Turbine Co., is now connected with W. B. Connor, Inc., 90 West St., New York City, in a similar capacity.

E. C. BRANDT, works manager of the Westinghouse-Krantz Works, has been appointed works manager of the new plant now being erected by the Westinghouse Electric & Mfg. Co. in Homewood, Pittsburg, Pa.

T. A. MARTIN, for many years connected with the George H. Smith Steel Castings Co., Milwaukee, Wis., became general superintendent of the Farrell-Cheek Steel Foundry Co., Sandusky, Ohio, on December 1.

C. G. TAYLOR has been appointed director of purchases of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. C. G. Bunnell has been appointed purchasing agent of the East Pittsburg Works to succeed Mr. Taylor.

GEORGE MACNOE, manager of the Boston office of W. B. Connor, Inc., has been transferred to the main office at 90 West St., New York City, to take charge of the contractors' sales department, which handles heating and pumping equipment.

G. A. SAWIN, assistant to the manager of the supply department of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been elected chairman of the committee on instruments and measurements of the American Institute of Electrical Engineers. He has been a member of the committee since 1920.

S. L. AYR has become manager of the Detroit territory of the Bantam Ball Bearing Co., Bantam, Conn. His headquarters will be at 905 Dime Bank Bldg., Detroit, Mich. Mr. Ayr has been assistant general manager of the Central Products Division of the General Motors Corporation, and previous to that was for twelve years production manager of the Truck Division of the Packard Motor Car Co.

L. F. CARLTON, who was connected with the Consolidated Press Co. for eighteen years and consequently has a wide acquaintance among power press users, has been appointed western sales manager of the V. & O. Press Co., Brooklyn, N. Y., manufacturer of power presses and sheet-metal working machinery. The western office of the company is located at 549 Washington Blvd., Chicago, Ill. A stock of presses will be carried in Chicago, available for immediate shipment.

ARTHUR L. COLLINS, for the last six months associated with the Standard Steel & Bearings, Inc., has entered the tool and alloy steel department of Horace T. Potts & Co., Philadelphia, Pa., as sales metallurgist. His work will be with the various mills turning out the Potts brands of steels and with the users of these steels in advising on applications and heat-treatments. Mr. Collins graduated from Stevens Institute of Technology in 1914, and was with the Atlas Ball Co. as engineer of tests and metallurgist until 1920. He has been secretary and treasurer of the Philadelphia chapter of the American Society for Steel Treating since its inception.

L. M. WAITE has been appointed general manager of the Garvin Machine Co., Spring and Varick Sts., New York City. Mr. Waite started his experience in the machine tool business with the Cleveland Automatic Machine Co., Cleveland, Ohio, as office boy and worked his way up until he became a salesman. He then entered the service of the National Acme Co., Cleveland, Ohio, and occupied positions in various capacities in both shop and sales work. He left the National Acme Co. after having been one of the company's sales managers for many years. During the following eight years he was identified with the machine tool industry in New England in both a manufacturing and a sales capacity, and he was sales manager of the Garvin Machine Co. for a year and a half, until he was made general manager on December 1.

F. F. ROHRER, assistant to the manager of the power and railway departments of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been appointed general contract manager of the company. He will have general supervision of all contract and order work, and in addition to this general work will continue to have direct charge of the contract work of the power and railway departments. Mr. Rohrer became connected with the Westinghouse Electric & Mfg. Co. as a student in 1896. After serving in the shops for four years, he was transferred to the sales department. During the war he was a member of the committee of the War Industries Board appointed to conserve the production of turbine generating equipment for government needs, and after the signing of the armistice, he became the representative of the Westinghouse company in the settlement of contracts that were terminated as a result of the ending of the war.

* * *

OBITUARY

HENRY L. KINSLEY, Wellesley, Mass., New England representative of the Warner & Swasey Co., Cleveland, Ohio, died Wednesday, November 22, at the Natick Hospital, Natick, Mass., following an operation. Mr. Kinsley was born in Stoughton, Mass., sixty-eight years ago. Practically all his business life was spent in the machine tool industry. He represented the Warner & Swasey Co. with offices at Boston for more than fifteen years, and was one of the best known machine tool men in the New England territory. Previous to his association with the company, he was with the Fairbanks Co. and the Manning, Maxwell & Moore Co.

* * *

AUTOMOBILE AND TRUCK PRODUCTION

The following table gives complete figures of the number of passenger cars and trucks manufactured for the first eight months of 1922, as published by the Department of Commerce. The reports collected by the Department cover ninety passenger car manufacturers and eighty makers of trucks.

1922	Passenger Cars	Trucks
January	81,693	9,416
February	109,171	13,195
March	152,959	19,761
April	197,216	22,342
May	232,431	23,788
June	263,027	25,984
July	224,057	21,357
August	246,941	24,064

* * *

FOREIGN TRADE SERVICE

The National Foreign Trade Council, India House, Hanover Square, New York City, has started a department known as the Trade Advisory Service, the object of which is to provide a medium for the interchange of foreign trade information. Manufacturers with foreign trade problems may submit their problems in writing to the Trade Advisory Secretary at the office of the National Foreign Trade Council. These problems will then be submitted confidentially to three or more men with wide experience in the particular field to which the inquiry refers. The replies will be gone over and condensed into a single answer, containing as clear and concise information as possible. It is believed that this service will be of particular value to the manufacturer entering the export field, but it will also be of value to the manufacturer with past experience, as it will enable him to obtain opinions upon new policies and provide him with a method of checking up his present practice with the experience of others.

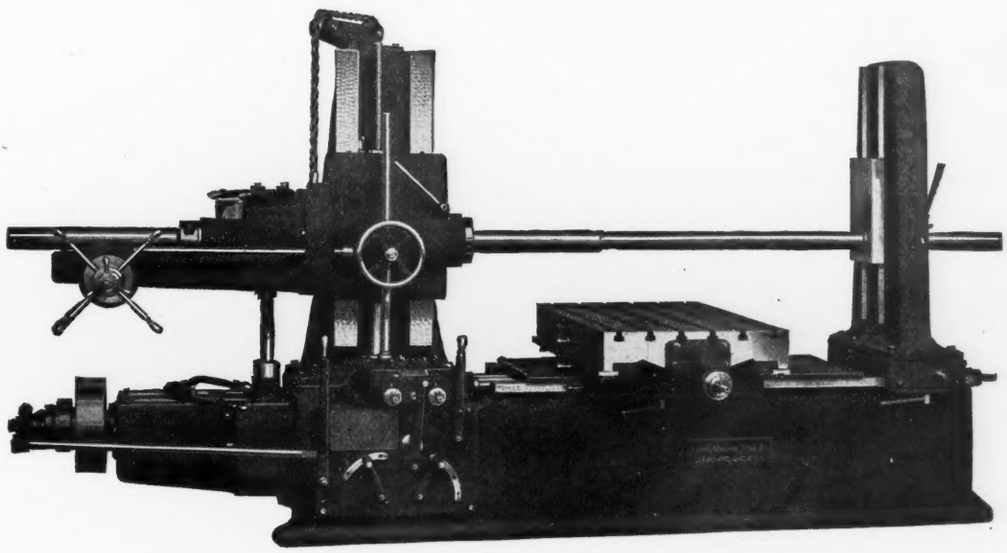
* * *

The United States Civil Service Commission, Washington, D. C., has announced a vacancy for a mechanical engineer of tests, in the aeronautical engineering laboratory at the Navy Yard, Washington, D. C. The duties of the engineer are to act as technical advisor and to take actual control of testing and designing work. Applications must be received not later than January 30. Further information can be obtained from the U. S. Civil Service Commission, Washington, D. C.

* * *

F. W. Aston of Trinity College, Cambridge, England, by his important experiments has laid a firm foundation for the belief that many substances hitherto regarded as elements are in reality not elements at all, but mixtures of "isotopes," that is, of genuine elements whose atomic weights are not far apart and whose chemical properties are identical, or at least so nearly so that chemical methods are incompetent to separate the constituent isotopes.

"A ship is a ship only when she's sailing"—
And so a boring machine is a boring machine only when she's boring; and the same with a drilling or a milling machine.

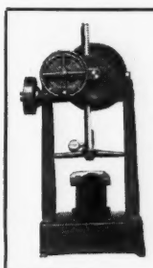


When the

"PRECISION"

Boring, Drilling and MILLING MACHINE

is not doing one thing she is doing another, and often does all three at one setting of the work, therefore *Never Stands Idle.*



WE ALSO MAKE THE
LUCAS POWER
Forcing Press

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

TRADE NOTES

ARVA STROUD announces the removal of the company's offices from 327 Broadway, New York City, to the Woolworth Bldg., 233 Broadway.

LARCHAR-HORTON CO., specialists in advertising have moved into new and more commodious offices in the Franklin Block, 44 Franklin St., Providence, Rhode Island.

AIR REDUCTION SALES CO. announces that the executive offices of this company are now located at 342 Madison Ave., New York City, and that the offices formerly maintained at 120 Broadway and 160 Fifth Ave., are now consolidated at the new address.

MONITOR CONTROLLER CO., Baltimore, Md., manufacturer of the "Just-Press-a-Button" system of automatic control for motor-driven apparatus, has recently established a branch office at 1100 Elm St., Birmingham, Ala., of which William H. Neville is in charge.

PORTER-CABLE MACHINE CO., 1708-12 N. Salina St., Syracuse, N. Y., manufacturer of lathes and milling attachments, has appointed Wm. Battersby, 3325 N. 21st St., Philadelphia, Pa., exclusive agent in the Philadelphia territory, for the lathes manufactured by the company.

HANNIFIN MFG. CO., 621-631 S. Kolmar Ave., Chicago, Ill., manufacturer of air-operated chucking equipment and adjustable boring and reaming bars, has appointed George J. Keller district representative of the company for northern Ohio with headquarters at 14411 Savannah Ave., Cleveland, Ohio.

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburg, Pa., has taken a lease on a six-story building to be erected on a lot 100 by 150 feet, at Jones Ave. and Marietta St., Atlanta, Ga. The building, which is to be known as the Westinghouse Electric Bldg., will be constructed according to the company's specifications, and will be used as an office, warehouse, and service station.

CARPENTER STEEL CO., Reading, Pa., manufacturer of alloy and tool steels, announces that a report recently given wide publicity concerning the merger of the company with some other steel concern or its sale to other interests is entirely erroneous. No such negotiations are pending, and it is not contemplated that any change will be made in the present ownership and management.

PETER A. FRASSE & CO., 417 Canal St., New York City, has been appointed exclusive eastern distributor for the electric carbon, alloy, and tool steels in bars, billets, and die-blocks manufactured by the Sizer Steel Corporation with plants at Buffalo and Solvay (Syracuse), N. Y. The FRASSE STEEL WORKS, INC., Hartford, Conn., will act as exclusive New England distributor for the same company.

V & O PRESS CO., manufacturer of presses, dies, and sheet-metal working machinery, for many years located at Glendale, Brooklyn, N. Y., has started work on a new factory at Hudson, N. Y., to which the business will be moved about May 1, 1923. The new plant will provide increased facilities for the manufacture of the company's products, and will also enable the company to broaden the scope of its operations.

CANEDY-OTTO MFG. CO., Chicago Heights, Ill., manufacturer of radial drilling machines of various types and other shop equipment, has put into operation a credit plan which permits the sale of the company's equipment by jobbers on terms of from four to twelve months. The plan is underwritten by the Continental Guaranty Corporation of New York, and will prove particularly advantageous to the garage or repair shop owner.

INGERSOLL-RAND CO. and the A. S. CAMERON STEAM PUMP WORKS announce the opening of a branch office at 718 Ellicott Square Bldg., Buffalo, N. Y. The new office is equipped to render full service to those interested in air, gas, and ammonia compressors, vacuum pumps, turbo blowers and compressors, condensers, oil and gas engines, pneumatic tools, rock drills, centrifugal and direct-acting pumps, and other products manufactured by these companies.

WILMARTH & MORMAN CO., 1180 Monroe Ave., N. W., Grand Rapids, Mich., manufacturer of grinding machinery, will be exclusively represented by the following dealers in the territories specified: Manning, Maxwell & Moore, Inc., for the states of New York, New Jersey, Delaware, Maryland, and Pennsylvania east of Altoona; and Brown & Zortman Machinery Co. for the state of West Virginia, the western part of Pennsylvania, and the southeastern part of Ohio.

DIAMANT TOOL & MFG. CO., Inc., 95 Runyon St., Newark, N. J., has appointed the Kemp Machinery Co., 215 N. Calvert St., Baltimore, Md., exclusive representative for the sale of Diamant standard punch and die sets, in the territory covered by the states of Maryland, Virginia, District of Columbia, and West Virginia, consisting of Jefferson, Berkley, Morgan, Hampshire, Mineral Hardy, Grant, Pendleton, Randolph, Pocahontas, Green Brier, Monroe and Mercer counties.

SIMONDS MFG. CO., Fitchburg, Mass., and Chicago, Ill., announces that the company's president, Alvan T. Simonds, has offered two prizes of $1000 and $500 for the best essays written by students of high schools and normal schools in the United States and Canada on the subject of "The Lack of Economic Intelligence and Some of the Injuries it has Caused Individual and General Welfare in the United States since 1860." Rules governing the contest may be obtained by addressing the Simonds Economic Prize Contest, 470 Main St., Fitchburg, Mass.

GENERAL ELECTRIC CO., Schenectady, N. Y., announces that a fund of $400,000 has been set aside to be known as the Charles A. Coffin Foundation, the income from which, amounting to approximately $20,000 a year, will be used for encouraging and rewarding service in the electrical field by giving prizes to its employes; by providing recognition to lighting, power, and railway companies that have instituted improvements in the service to the public; and by giving fellowships to graduate students for research work at technical schools and colleges.

REED-PRENTICE CO., Worcester, Mass., announces that the company has purchased the good will, business, and part of the plant equipment of the BECKER MILLING MACHINE CO., Hyde Park, Mass.; and the WHITCOMB-BLAISDELL MACHINE TOOL CO., Worcester, Mass. The Reed-Prentice Co. will in the future manufacture the products of the two companies mentioned in its own plant at Worcester. This gives the Reed-Prentice Co. a larger line of well-known machine tools, and makes it possible to run the company's sales, engineering, and operating divisions at greater capacity, whereas before, all three companies were burdened with decidedly over-expanded plants and organizations, due to the expansion that took place in practically every industry and every plant during the war. The products will carry their former names, but all manufacturing will be concentrated at the Reed-Prentice plant, and the selling will be done by the sales force of this company.

ROLLER-SMITH CO., 233 Broadway, New York City, manufacturer of electrical instruments, meters, circuit breakers, and radio apparatus, has appointed the Electric Material Co. as its agent in the state of Washington, and parts of Oregon and Idaho. The Electric Material Co. has recently opened an office in the Hinckley Bldg., Seattle, Wash., and will handle the Roller Smith Co.'s line of electrical instruments in that territory. The main office of the company is at 589 Howard St., San Francisco, Cal., and it also has a branch office in the Title Insurance Building in Los Angeles, both of these offices also handling Roller-Smith apparatus. The Seattle office is in charge of R. F. Robinson, who has been engaged in the electrical industry since 1905, when he graduated from the University of Wisconsin with the degree of electrical engineer. He spent several years in the manufacturing department of the Western Electric Co., and later entered business for himself, first in the electrical supply line and later as a manufacturers' representative.

* * *

BUILDER OF CYLINDER BORING MACHINE

In the description of a machine designed by the Manufacturers' Consulting Engineers, Syracuse, N. Y., for boring air-cooled gas-engine cylinders and finishing the head of the cylinders at the end of the bore, which appeared on page 324 of December MACHINERY, it should also have been mentioned that this machine was built by the Meldrum-Gabrielson Corporation, Syracuse, for the H. H. Franklin Mfg. Co., of the same city.

* * *

METHODS FOR CHEMICAL ANALYSIS OF BABBITT METAL

The American Engineering Standards Committee, 29 W. 39th St., New York City, has approved as tentative American standard the methods for the chemical analysis of alloys of lead, tin, antimony, and copper—otherwise known as babbitt metal—submitted by the American Society for Testing Materials. Two methods of analysis are included in the procedure approved. The first is a quick and fairly accurate method intended for practical or shop use; the second is a slower, more elaborate, more expensive, but more exact method intended for reference purposes or for the settlement of disputed questions.